PUBLIC WORKS

Devoted to the interests of the engineers and technical officials of the cities, counties and states

JANUARY, 1939

A. PRESCOTT FOLWELL, Editor — VOL. 70. NO. 1 — W. A. HARDENBERGH, Asso. Editor

Contents

TIMEWASTERS

The "log" problem in the December issue was hardly a twig for our able timewasters. It took them longer to tell how it was done than it did to do it. Simple, of course. Since 3 is the log of 1000, it is a simple matter of dividing 16 into 1000, whence comes the answer, 16.

We have before us some unfinished business from the October and November issues, also. Says Mr. Houtman: "You got me in an awful jam. To solve the problem of the four o'clock time piece (see October), I had to cut the hands off our grandfather clock to 3 and 4 ins. respectively, wait for 4 o'clock and measure the distance between the points, which was 6 3/32 ins. Don't tell me it's wrong for I don't want to spoil any more clocks. And was my wife's face red when she saw what I had done. Also, that Johns-Manville parader that ducked into a tap room ought to be fired and get a job back of a bar. He made me waste exactly three hours, which however ran concurrently with the time that I was waiting for the clock to reach four o'clock. But I certainly feel sorry for his co-paraders who stuck it out while the marshal was scrambling them in his trial and error method. They must have felt as important as asbestos fibers in a sheet of expansion material."

Mr. Blunk says that Ikey and Mikey were 4 and 11 years old, respectively (see December). But 9 and 12 should also work. Regarding the concrete gang (November) they started with 13 sacks on hand and used 36 sacks the last hour.

For Surveyors Only:

I have a square lot, within which stands one lone tree. This tree is 30 ft., 40 ft. and 50 ft. distant, respectively, from three successive corners. How much land do I have?

Cleveland Engrg. Soc.

And For the Office Engineer:

Between two towns, the road is level for half the distance, then one hill up and one hill down. The speeds on a bicycle are 3, 6 and 9 miles an hour, up hill, on the level and down hill, respectively. It takes 5 hours and 45 minutes to go and 4 hours and 45 minutes to return. What are the lengths of the level road and of the two hills?

John Bevan.

After the holidays, we're still a little disorganized, and on the supposition that our readers may be, too, we're making the Timewasters unusually easy this month. Best regards.

W. A. H.

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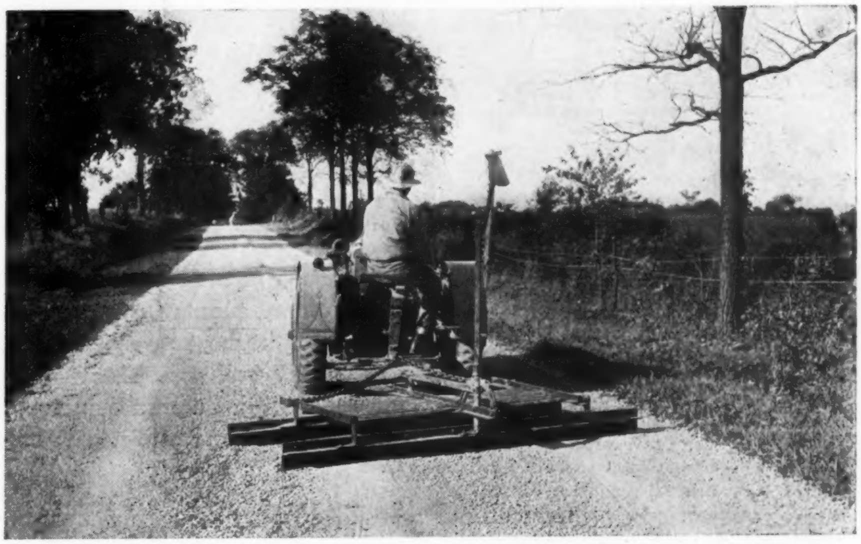
Vol. 70, No. 1

The maintenance man is the conserver of our highway investment



This text was drafted initially in the office of PUBLIC WORKS magazine. Sixty copies were mimeographed and sent to highway engineers, maintenance men, manufacturers, etc., for checking, criticisms and suggestions. The text herewith is the result of this cooperative effort. The publishers of PUBLIC WORKS wish to take this opportunity to thank most heartily for their help the men whose names are given below.

How to Maintain Streets and Highways

The text of this article begins on page 19.

Prepared by W. A. Hardenbergh, With the Help of the Following

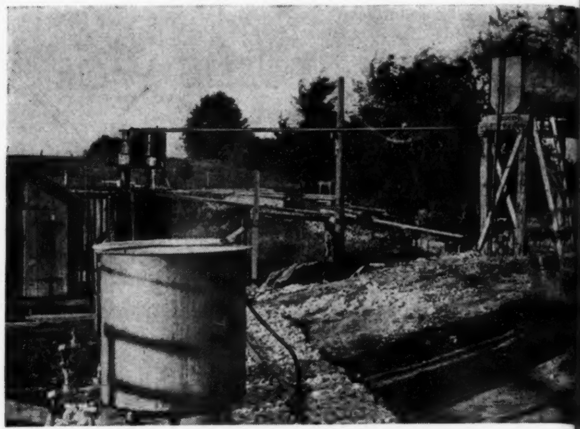
A. J. Wiggin, Supt. of of Maintenance, State Highway Commission of Maine.
F. H. Klietsch, Maintenance Engineer, Nebraska Department of Roads and Irrigation.
B. W. Davis, Maintenance and Equipment Engineer, North Carolina State Highway and Public Works Commission.
C. W. Brown, Chief Engineer, Missouri State Highway Department.
Leon Gottlieb, Bituminous Engineer, Alabama State Highway Department.
H. S. Perry, Maintenance Engineer, Ohio Department of Highways.
D. H. Dickinson, Chief Engineer, New Hampshire Highway Department.
Samuel W. Marshall, Chief Engineer, Pennsylvania Department of Highways.
B. R. Downey, Maintenance Engineer, Michigan State Highway Department.
E. L. Gates, Superintendent of Highways, Dupage County, Ill.
S. E. Fitch, County Superintendent of Highways, Chautauqua Co., N. Y.
R. H. Ireland, Ass't. Engr. of Maintenance, Kansas Highway Commission.
Leon V. Belknap, Engineer-Manager, County Road Commission, Oakland Co., Mich.
W. H. Spindler, Armco Culvert Mfrs. Association.
J. H. Conzelman, Alabama Asphaltic Limestone Co.
J. L. Connors, Galion Iron Works & Mfg. Co.
G. R. Christie, Standard Oil of New York.
G. E. Martin, Consulting Engineer, Tarvia Division, Barrett Co.
A. R. Taylor, Consulting Engineer, Tarmac Div., Koppers Co.
B. E. Gray, Chief Highway Engineer, Asphalt Institute.
B. C. Tiney, Calcium Chloride Association.
J. F. Richardson, Buffalo-Springfield Roller Co.
G. M. Walker, Caterpillar Tractor Co.
H. F. Barrows, Austin-Western Road Machinery Co.
D. A. Milligan, Cleveland Tractor Co.
W. R. Macatee, The Asphalt Institute.
A. J. Roof, Toncan Culvert Mfrs. Assn.

A number of letters, without specific suggestions or criticisms, were received. For these, we wish to extend our thanks to C. A. Beal of W. A. Riddell Corp.; E. E. Christena, J. D. Adams Co.; W. H. Root, Maintenance Engineer, Iowa State Highway Commission; G. E. Hamlin, Deputy Com'r of Maintenance, Connecticut State Highway Department, W. E. Worcester, Kinney Mfg. Co., and others.

Wherever possible, credit has been given. There is, however, exceedingly little information on methods of maintenance that is available to the average engineer. Far too much of it exists in the form of memoranda, circulars, reports and papers, which can be found in very few libraries; a few references are given at the end of this section, but most of these are not for sale. A bibliography is being prepared and will probably be published following the last installment of the article.

Turn to page 19

Experiments on Treatment of Cannery Wastes



Cedarburg experimental plant, showing fill and draw type p cipitation tanks in the foreground, biological filters beyond.

Cannery wastes furnish the toughest problem to sewage treatment plants in many municipalities, and to all such the best way of treating them is a continuing vital problem. This is a preliminary report of results from a comprehensive, cooperative study of canners and health boards.

THE wastes from canning plants have been found to cause objectionable stream pollution and nuisances in many localities throughout Wisconsin and other states, and have been the subject of considerable investigation to determine effective and practical methods of treatment. The Wisconsin Canners Association, the National Canners Association and the Wisconsin State Board of Health have been conducting a cannery waste program, and during the past summer studies were made at Cedarburg, Wis., by N. H. Sanborn, chemist for the national association; Frank McKee, state district sanitary engineer, and Harvey Wirth, in-service-training apprentice. The following briefly summarizes the results obtained, which are submitted as a preliminary report, for which, and for the illustrations, we are indebted to L. F. Warrick, State Sanitary Engineer of Wisconsin.

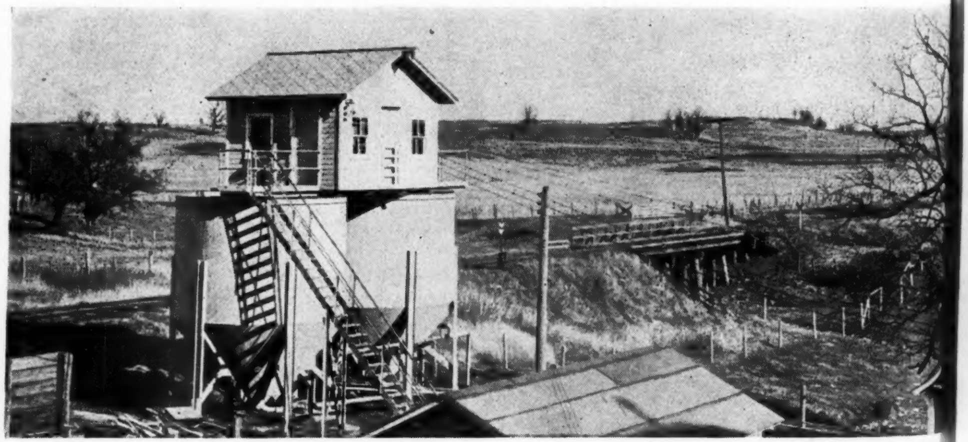
Experimental Results

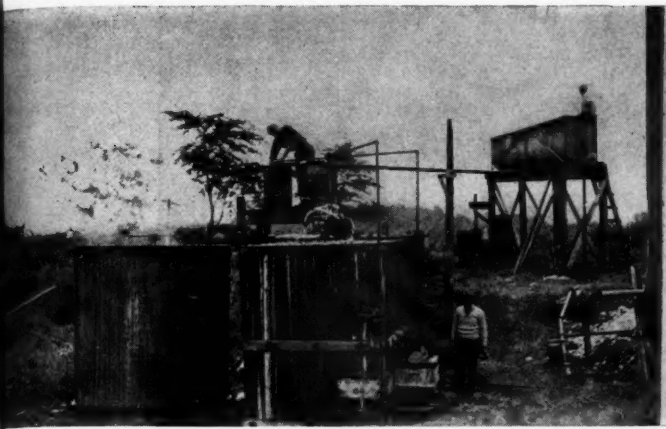
The first and most important step in the treatment of cannery waste is efficient screening. Experience has indicated that waste should be screened through a rotary screen equipped with a 40-mesh wire and an efficient water spray. Some canners have reported that a 20-mesh wire is the finest that can be used but it has been shown that a 40-mesh wire provides more efficient screening and will not clog when properly washed and otherwise suitably maintained.

The problem of cannery waste treatment was attacked from two angles, chemically and biologically. The chemical treatment of the waste consists of precipitation by the addition of suitable coagulants of finely divided solids remaining after screening, thus clarifying the waste, and removing a substantial portion of the unstable organic matter as measured by the oxygen demand test. The second method of treatment consists of the biological oxidation of the waste by allowing it to trickle through a filter consisting of crushed rock or other suitable material presenting a maximum amount of contact with growths of organism which feed upon and stabilize organic matter. All experiments were conducted on the screened waste, and the reported efficiencies are on the basis of screened waste. Work on the treatment of pea cannery waste showed that the previously developed chemical treatment with lime and ferrous sulphate gave the best results. The substitution of alum for ferrous sulphate gave nearly equal efficiencies.

It was found that a certain conditioning period is necessary with the biological treatment before effective results are obtained. During this period the efficiency of the biological filters, which were operated at a rate of 458 gallons per square foot of filter surface area per day (equals 20 mgad), gradually increased over a period of about ten days. This conditioning period, during which the efficiencies are low, is a material handicap to the use of a biological filter in the treatment of cannery waste. Tests would indicate that under special conditions a growth could be built up by the use of some other waste prior to the canning season. In such cases this means of treatment would prove effective.

Analysis of beet canning waste showed that it contained a considerable amount of fine organic solids, together with sand and dirt. The waste is of a dark red color containing considerable dissolved organic matter. In the chemical precipitation experiments of beet waste, practically all of the common coagulants were tried including ferrous sulphate, ferric chloride, Ferrisul.





High-rate trickling filters, with recirculation, used after passage through a 40-mesh rotary screen, or following chemical treatment.

Construction of tile filter, showing constant-head dosing tank at the left and rotary distributor for spreading wastes uniformly over the filter.

alum, Bentonite, Otalite and zinc chloride. The waste has a higher oxygen demand than the pea canning waste. The most effective chemical treatment consisted of the application of ten pounds of lime and about four pounds of ferrous sulphate per thousand gallons of waste. It is known that the addition of lime only will cause the characteristic color change in the waste and is responsible for about 80% of the total reduction in oxygen demand. The addition of ferrous sulphate accomplishes more rapid settling of the precipitate and better clarification of the liquid waste. The color of the treated waste is amber or orange and is free from suspended solids. Small scale experiments at Cedarburg showed an average oxygen demand reduction of 59%. The sludge obtained from the treatment of beet waste dries well and the volume is about the same as that obtained from the treatment of pea waste. Thorough agitation during the mixing of the chemicals with the waste is necessary to effect satisfactory clarification. Laboratory experiments on the precipitation of beet wastes with lime and zinc chloride gave an oxygen demand reduction averaging 85%. However, the dosage necessary to obtain a water white effluent would be comparatively high in cost. Further studies along this line are believed desirable.

Biological treatment of beet waste on the experimental trickling filters showed that an oxygen demand reduction of about 60% can be obtained by six passages through the filter at a rate of 458 gallons per square foot per day. At the end of this number of passes the color of the settled filter effluent is a characteristic amber or yellow, and the suspended matter almost completely removed. The presence of sand and grit in the beet waste would make it necessary to provide facilities for removing this material before pumping the waste. A clarifier for sedimentation and storage of the waste would also be necessary. Uniform dosing of the waste to the filter is essential. The experimental results indicate that secondary settling is of advantage for further oxygen demand reduction. Results show that settling for as long as one-half hour will reduce this oxygen demand another 10% to 15%.

A chemical treatment for corn waste was developed which produces an oxygen demand reduction of about 60% and the production of a water-white effluent. This treatment consists of the application of eight to ten pounds of lime and nine to twelve pounds of ferrous sulphate per thousand gallons of waste. It is important to add the ferrous sulphate in several steps, that is, the first dosage should be about three-quarters of the necessary amount and the remaining chemical added in small batches with continuous agitation. Effective treatment is attained when the green floc becomes large and curdy and settles rapidly, leaving an absolutely clear and colorless liquid. Any cloudiness in the liquid may be removed by the addition of a small amount of ferrous sulphate. The experiments conclusively show that if the iron dosage was added all at one time the waste would remain cloudy regardless of the amount of chemical used.

Experiments with biological oxidation of the corn waste show that six passages through the rock filter at a rate of 458 gallons per square foot per day gave an oxygen demand reduction of 75%.

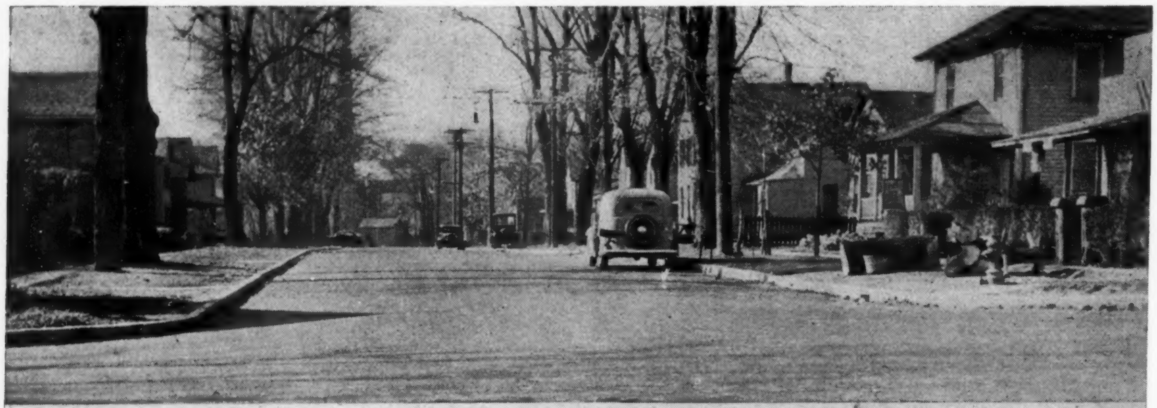
Tomato waste produced at a cannery not packing tomato juice has a relatively low oxygen demand when compared with other cannery wastes. The tomato waste has a light reddish-brown color, most of which is due to the suspended material. Sedimentation of this waste will result in a marked clarification. Coagulants giving best results were lime and alum. Overdosage of the waste with iron salts produced a colored effluent. Precipitation with zinc chloride gave good results and warrants further study.

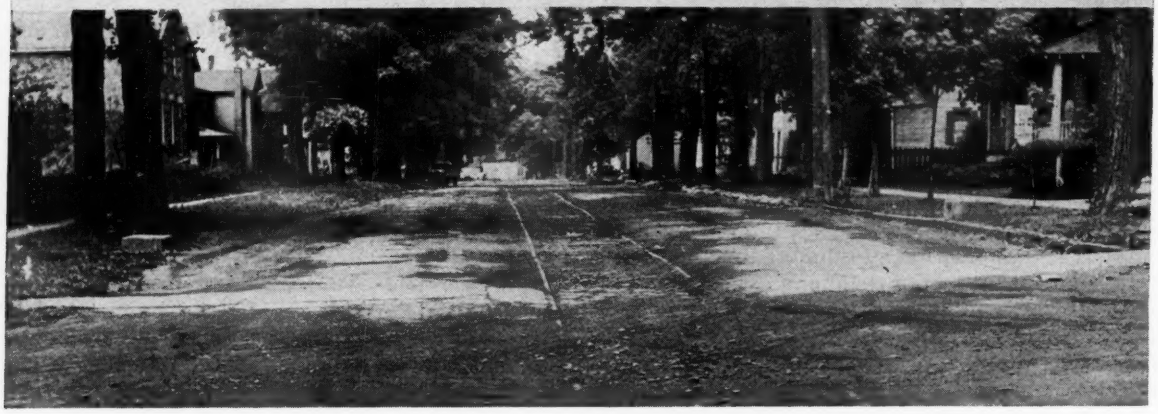
The volume of water used averages about 3.3 gallons per No. 2½ can. In cases where considerable dilution is available in the receiving stream, efficient screening of the waste together with sedimentation of the suspended material, should provide sufficient treatment. If further treatment is necessary, experiments indicate that dosages of four pounds of lime and one pound of alum per thousand gallons of waste give the best results. The chemical precipitate is light and settles slowly thus making a two hour settling period necessary. An average oxygen demand reduction of 50% can be expected by chemical precipitation.

A 65% reduction of the oxygen demand of this waste can be obtained with three passes through the biological crushed rock filter at a rate of 458 gallons per square foot per day. The settled effluent from the filter was clear and colorless.

Waste from carrot canning operations can be satisfactorily treated by precipitation with five pounds of lime and one pound of ferrous sulphate or with eight pounds of lime alone per thousand gallons of waste. Sufficient agitation should be provided to produce a medium size floc which will settle, leaving a light yellow colored effluent with a reduction in oxygen demand averaging 75%. *(Concluded on page 49)*

Cannery waste treatment plant, typical of those embodying chemical precipitation that have been installed in Wisconsin.





An old pavement with no drainage and high maintenance cost below, and the same after reconstruction, above.

Old Material Makes Good Base for Modern Street Surface

By LEON H. WENDEL

Commissioner of Public Works, Lockport, N. Y.

FOLLOWING three years of W.P.A. and five years of other types of relief work, no doubt other cities, like ourselves, looking back over the eight years, are seriously condemning themselves (as we have) for having had a part in some of the worthless projects carried out, such as water and sewer lines in the wilderness, huge earth-moving jobs simply to make work, cleaning drainage ditches that functioned without cleaning for the last twenty-five years, cutting fire wood of questionable value, and countless other such works. All this primarily because we were loaded with an unprecedented number of workers and told to put them to work with no time for planning and with a hope that each year would be the last, only to find that "temporary" emergency relief has now become "permanent." With this realized, however, we are now able to plan in a constructive way an annual paving, sewer or water program to cover a given period of time—usually six months or a year—and then proceed with its construction in an orderly fashion.

Work relief to writer means an obligation to four classes of people —to the Government, the sponsor, the worker and, last but not least, the local taxpayer. To the Government, because slowly they are having to show a real need for the project; to the sponsor because the local government is expending large sums and should have something to show the taxpayer for his money; to the worker, because he deserves a project that is a real benefit to the community, as he is working for a wage and has the right to expect a job to do that completes a project of civic pride; and to the taxpayers who daily are paying more for local relief (work and outright grants) and have reason to believe that projects of community-at-large good are the proper type; projects that benefit all rather than the residents of one single street.

Predicated on that premise, we have set up main and sub feeders, water lines, relief sewers that rectify bad sewer conditions in whole territories, and a street paving program throughout the city so that the travelling public can get from one part of the city to another without thinking of the horse-and-buggy days or creating too great a dust nuisance to the adjoining property owners.

At Lockport, old pavements plus WPA labor gives new ones. All the old paving material is used in the new, and a long-range program has been worked out for thus securing many miles of new pavements and curbs at remarkably low cost.

Such a program of paving required a great deal of study. Some

type of low-cost pavements had to be selected to keep the cost of the sponsor at a minimum. In this city three years ago no one was willing to pay for pavements by local assessment on front footage basis, even if the cost was only one-half of the regular contract pavement of the boom times. Taxes were high due to the relief load and all felt lucky if able to pay taxes, let alone paving assessments. Some other solution was necessary, and after much study it was found in salvaging the old base that was in pavements that had been constructed piecemeal over a long period of time, as the roadway progressed from a mud street to the present bituminous-treated street, uncurbed and much higher in most cases than the sidewalks, but a passable travelled surface that did not break up too badly under winter conditions although enough to cause high maintenance patch work every spring. It was thought that using this material in the base of the new pavement and covering it with new stone and top material would give a pavement durable for a residential street restricted against pounding of truck traffic.

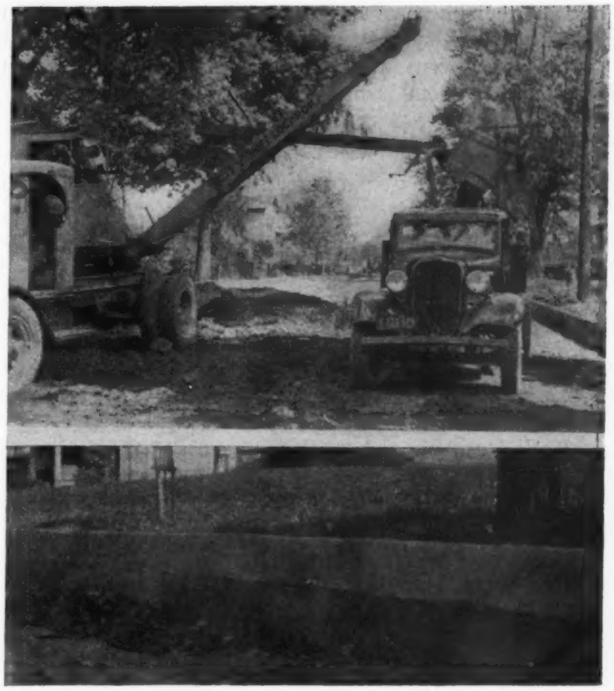
The road material in most of these old pavements varied from 6" to 10" of stone with bituminous binder on top, and in width from 10 to 20 feet, and investigation of a half dozen streets in various parts of the city indicated that we could reasonably expect to salvage sufficient stone to make a base with 5" rolled thickness and from 26 to 30 feet wide. To do this, the following section was planned.

On each side of the roadway a 6" x 18" concrete curb is laid on a 6" foundation of No. 2 stone, tile omitted; the curb grades being established regardless of the present elevation of the pavement. Between the curbs is placed a 5-inch water-bound base, using the salvaged stone mentioned above, and over that is placed a 3" rolled penetration course of No. 3 stone; and, as a last operation, a 1" course of fine Amesite top is placed to waterproof the surface. (More will be said about this later.)

The width of the pavement varies. Where possible, trees and right-of-way width not troubling, 30 ft. is maintained, using 26 ft. as the absolute minimum. In only one or two cases have we been forced to 24 ft. because of trees, but it is felt that everything should be done to maintain 26 ft. at least, and wherever possible 30 ft., because that is none too wide even for residential areas. The crown in all cases is made 4" because of simplicity of construction and the type of labor available.

Equipment

Three years ago we realized that the theory of doing everything with relief labor was not the answer. We felt that if enough equipment was added to the job to do the hard work and heavy excavation, we could get many times more legitimate work out of the labor, to the advantage of the city's interests.

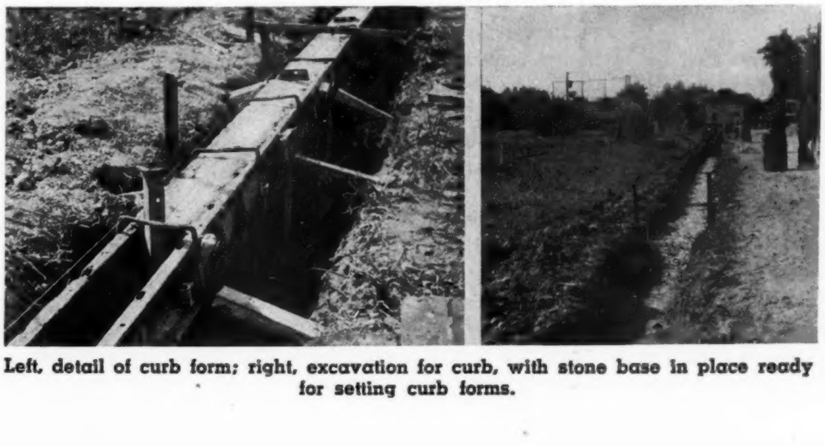


Top—Grading beneath salvaged stone. Bottom—Curb stripped of forms; upper 8" of face rubbed and edged.

We did not believe, for instance, that it was correct to expect progress trying to move two- or three-foot cuts of earth with hand labor, particularly when we were paying for all the trucks on the job. Accordingly we purchased a truck shovel $\frac{3}{8}$ cu. yd. capacity and immediately hauled twenty-five loads of dirt per day per truck as compared to five and six loads hauled during the hand loading era. Also we purchased a 10-ton used three-wheel roller and a concrete mixer. All trucks are rented and, keeping in mind at all times that the work is fundamentally relief, we use those of $1\frac{1}{2}$ C.Y. capacity in the main, owned by the drivers who would be on relief themselves if this work was not provided. The work therefore has become almost double edged.

Organization

All work functions under the direction of the writer's office, all work originating in the Engineering Department and receiving inspection as to workmanship from that department. The field force is operated by a general superintendent hired by the city and working under the writer's direction. Under him all other supervision is done by W.P.A. foremen who were selected in the start not for their knowledge but rather their desire to learn and get something done. For example, the curb crew foreman is a young fellow with just a few years' experience in construction. The excavation and salvage movement, together with finished pavement operation, has been given to a former truck driver of W.P.A. but who, before the depression, had held a fairly responsible supervision job with one of the small industries in the city. This man had practically no previous experience except in the art of handling labor. Under him is a sub foreman on excavation,



Left, detail of curb form; right, excavation for curb, with stone base in place ready for setting curb forms.

and another one on penetration work, neither of whom had any previous pavement experience. In the short period of two years these men have learned their lesson well, and to them is due the credit for the success of the whole paving program today.

Procedure

After a job has been staked out to the desired line and grade, the curb crew is the first to enter. They build manholes and receivers in addition to setting and pouring curb. We picked as simple type of form construction as possible. Using about thirty men daily, they are now averaging, including radius curb, better than 200 ft. a day. All curb, after stripping, is backed up in the rear with about 6" of lean concrete for stability.

As the curb gang moves off a street, the shovel crew enters and proceeds as follows: First, the salvage stone is loaded and moved to the far end of the job until approximately 300 ft. of pavement has been removed. Then the shovel is returned to the starting point and excavates to the new subgrade as designated by the curbs, this dirt being disposed of at the nearest point of dump, usually in adjoining properties or to the various spots belonging to the city that need to be filled. This 300 ft. stretch is then fine graded.

The shovel then removes more salvage stone and this is carried back 300 ft. and deposited on the subgrade, and the 5" base is thereby formed. From here on it is only a sequence of dig salvage, move it to grade, and with it make 5" depth of the total 9" thickness of new pavement.

Now and then, but rarely, we find enough salvage to make only 3" or 4" thickness, and then we haul enough fresh stone from our municipal quarry to cover the subgrade to a depth of 3" and cover this with the salvage as it is drawn back. In three years of operation we have still to haul our first load of the salvage to the dump; it just isn't wasted.

It should be pointed out at this point that the salvage stone is not just junk. It is a mixture of No. 3 and No. 2 stone with enough dust and surface-treatment bituminum to make it bind into a base of almost the hardness of concrete. It has served as a wearing metal for 10 to 25 years, the only fault of the old roadway having been that it was too narrow and generally at a grade higher than the sidewalk.

With the base now completed, the finishing operation is just a matter of time. Over it a course of new No. 3 stone is spread, levelled to grade and covered with 1¾ gallons of penetration tar and chinked or covered with 10 to 20 pounds of No. 2 stone to the square yard. Care is taken not to fill totally the voids of the No. 3 stone, because we believe that 50% tar-coated stone should show on the surface as a prime and that not over 50 or 60% of the voids should be filled, so that when the premixed top is applied it will go into the voids, thereby stopping any possibility of pushing under traffic. Therefore just enough No. 2 cover is applied to allow immediate passage of a roller over the tar-coated stone.

After this operation has been completed on two or three streets we rent an Admun blacktop spreader and make an effort to cover all with about 1" (or 1 ton per 18 sq. yd.) of premixed material known as Amesite or type No. 3, New York State Highway specification. This material is mixed in a local privately owned plant and delivered onto the jobs with our own trucks. This operation entails only about ten days to cover the whole season's program, so that the time involved is neglible. An 8-ton tandem is employed during the top laying operation.

We believe that we have partially solved a problem that is confronting every municipal official in the country, that is, to do a type of constructive work at a minimum cost to the taxpayer and at the same time of greatest benefit to him, and still utilize the labor of the unfortunate worker who because of age, infirmity or misfortune, has now come to rely on the government for a job.

We have in this program used every bit of the material on the streets that could be salvaged and have produced a job second to none in workmanship, sightliness, grade and general usefulness and rideability. The time has passed when we can, in the construction of a street, junk all the old road metal and start fresh, because the relief load seems to be an ever increasing one on the property owner.

The results have been more than pleasing to the writer, for we are actually producing a street of the highest order and lowest cost to all concerned.

In 1936 we embarked on this program, building approximately one-half mile. In 1937 we stepped our production to 1½ miles, and reached our peak this summer with 2¼ miles of finished pavement. We are now laying plans for the construction of 2½ miles more in 1939. The total cost to the City of Lockport for the 1938 program has been approximately $45,000, including all materials, equipment and other supplies.

An estimate of the quantities and contract prices show that for $45,000 we have produced a pavement that would have cost the city by contract about $50,000 per mile or, for the season, a total $125,000. We believe the headaches have been worthwhile.

Corrugated Roads to Prevent Skidding

A 3,500-foot stretch of concrete road that has a corrugated surface was recently constructed by the Pennsylvania Department of Highways as an experimental project to increase highway safety. The corrugations, which are similar to the imprints of a heavy tire, were molded into the wet concrete by vacuum mats during construction. Advantages expected from the new process include further protection against skidding in all weather conditions, and a reduction in the glare from sun and wet surface. A humming sound is made by the tires passing over the corrugation, but the projections are set close enough together to prevent rough riding. The highway on which this experimental stretch was constructed carries an average daily traffic of 4,000 vehicles.

The new concrete surface, three inches thick, was laid without reinforcement over an old concrete road which had been swept clean and washed. After the concrete had been placed, vacuum mats were used to remove excess water and imprint the corrugations.

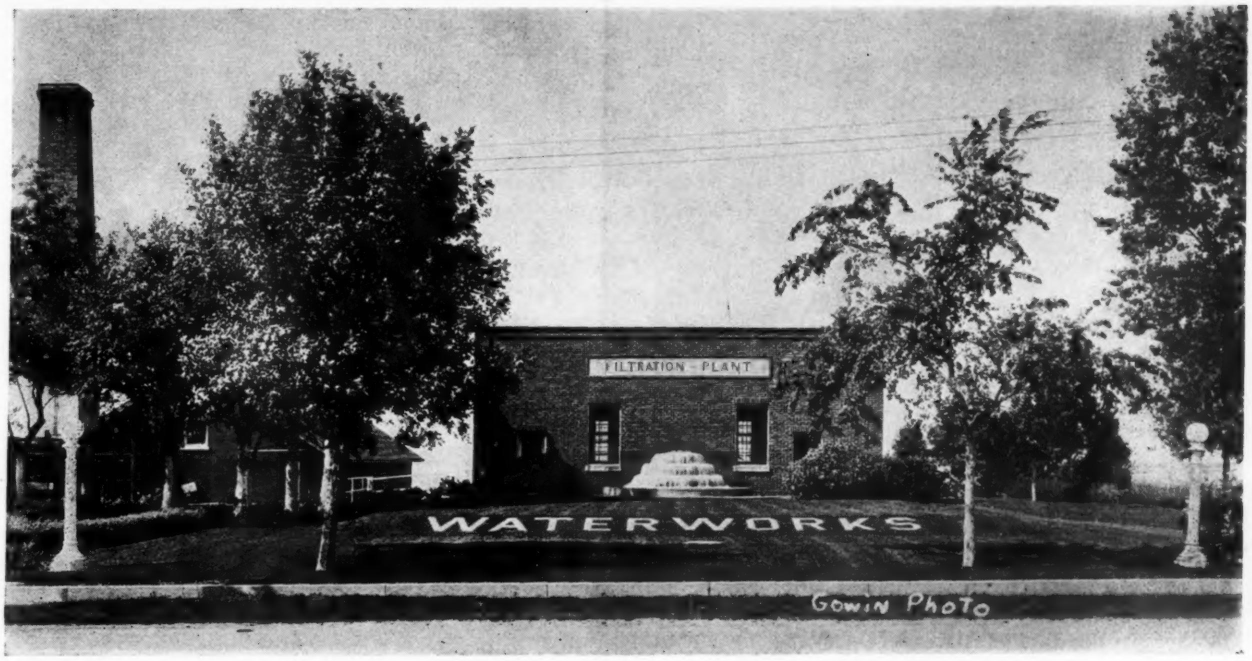
"Snow Farming"

In western Canada last winter some novel experiments were tried in order to hold snow on the fields and thus save the moisture for the crop.

The practice consisted of using a snow plow to form ridges of snow at right angles to the prevailing wind and thus cause subsequent snowfall to drift in between the ridges.

It will be interesting to learn just what effect this practice will show upon this year's crops.

If this practice proves useful, the job of snow plowing may become a common winter chore for tractors in those sections where moisture is scarce and much of the snowfall usually blows off the farm land.—*Tractor Farming.*



Watertown, S. D., water filtration plant.

How Watertown, S. D., Reduced Coagulant Demand With Bentonite

BY R. E. DRISCOLL, JR.
American Colloid Company

Watertown's water varied rapidly in turbidity between 30 and 200 ppm, was highly alkaline, the sludge from alum coagulation was difficult to dispose of, and chemicals cost about $10.00 per million gallons. Laboratory experiments indicated improvement by use of bentonite, and actual plant use has confirmed this.

THE Watertown, South Dakota, water filtration plant was built in 1922, being designed and constructed by Wm. Cochrane, who was then the city engineer and is now Regional PWA Engineer with offices in Omaha. It consists of intake and pumping equipment, preliminary aerator, two dry chemical feeders, mixing chamber, sedimentation basins, chlorinators and filter beds. The mixing chamber is 16′ 6″ by 21′ by 11′ deep, containing nine round-the-end baffles. There are two sedimentation basins, each 55′ by 21′. The design capacity is 1.4 mgd but it can handle 1.6 mgd easily. The daily consumption is about 1 mgd from September to June, but during the summer months averages 1.5 mgd. There are two standpipes on the system, of 1,000,000 gal. and 250,000 gal. respectively.

The plant is on the shore of Lake Kampeska, which is the source of supply. This lake has an area of about 5,000 acres, an average depth of 12 ft. and maximum depth of 20 ft. It is fed by several springs and is connected with the Sioux river by a channel through which river water flows into it when the river is high, but the lake discharges into the river when the latter is low. The lake is a glacial basin underlain with a stratum of water-bearing gravel about 30 ft. thick, on top of which an impevious layer of silt has collected through the centuries.

During the drought years 1934-'36 the lake receded to about half of its normal size and the supply became so uncertain that the city sunk several wells to the gravel stratum for an emergency supply.

Due to the shallowness of the lake, wave action stirs up the bottom silt, causing considerable turbidity of the water at times, which varies greatly from day to day or even hour to hour during the summer months between the limits of 30 and 200 ppm. During the winter the lake freezes to a depth of approximately three feet, eliminating the rapidly changing turbidity problem. The total hardness varies throughout the year from 200 to 300 ppm. A typical analysis of influent to the plant is as follows:

Turbidity	87 ppm
Total alkalinity, as $CaCO_3$	197 ppm
Carbonate alkalinity, as $CaCO_3$	0
Bicarbonte alakalinity, as $CaCO_3$	197 ppm
Free carbon dioxide	16 ppm
Total hardness	252 ppm
Carbonate hardness	197 ppm
Non-carbonate hardness	55 ppm
Magnesium	115 ppm

The pH ranges from 7.6 to 8.4.

The chemical treatment prior to filtration consisted of a dose of 1 to 2½ grains per gallon of aluminum sul-

R. E. Driscoll, Jr.

phate and ¼ to ½ grain per gallon of sodium aluminate. During periods of high consumer demand the retention time in the settling basins was not sufficient for proper sedimentation and sodium aluminate was used to speed up the alum flocculation and have the floc in proper condition before leaving the mixing basin. The dosages mentioned above have proven sufficient for proper clarification.

The sludge and wash water are discharged into the lake about 200 feet from shore and have built up a long peninsula of sludge and it is feared that this might in the near future present a serious taste and odor problem, although the intake is 1,500 feet from shore and the prevailing winds prevent immediate danger of this by preventing the peninsula from extending out into the lake. However, it is a definite problem. With this problem in mind and the possibility that chemical costs could be reduced, the plant superintendent, E. H. Schultz (who is now president of the South Dakota Water and Sewage Conference) decided to experiment with volclay, thinking it possible that this material, with its ability for absorbing taste and odor, might at least postpone any trouble. He also had in mind that the sludge resulting from bentonite treatment would be less chemically active and here again would help defer immediate trouble. This idea was later shown to be at least partially correct, because the bentonite sludge is practically odorless, while that resulting from the alum and aluminate treatment gave off disagreeable odor.

Research Work

Research work on the use of volclay bentonite in water treatment has been done by H. L. Olin, Professor of Chemical Engineering at the University of Iowa. Dr. Olin limits the bentonite most favorable for this process to the so-called Wyoming alkali clays, containing replaceable alkali bases, i.e., having zeolite properties and which, when dispersed in water relatively free from electrolytes, form remarkably permanent suspensions, but like all colloids in general they flocculate readily in the presence of oppositely charged ions. He distinguishes bentonite from the alkaline earth clays and fuller's earths, many of them of great industrial importance but lacking in general the peculiar colloidal properties of the clays in question.*

James E. Kerslake, Asst. Sanitary Engineer, New York State Department of Health, says: "Bentonites are alkali clays, which, upon contact with water, swell to volumes from five to ten times their original bulk. They are used as coagulants and have been found to be very effective in the treatment of turbid hard waters. Their use in water treatment is comparatively new and, before using bentonite on a plant scale, it would be well to experiment with it first in the plant laboratory." Before adopting this material, Mr. Schultz decided that such laboraory experiments should be conducted at Watertown. In these experiments a Black Hills high-swelling colloidal bentonite, known as volclay, was used.

Experimental Procedure

One litre quantities of the raw water were treated with varying dosages of volclay. These samples were kept at 20 degrees centigrade, and stirred for 10 minutes at 35 r.p.m. It was decided that ten minutes was not a long enough time for complete flocculation of the bentonite when used alone, and in order to coincide as much as possible with the short detention period in the plant mixing basin, it was necessary, as with the alum treatment, to speed up the reaction.

Flocculation with alum is brought about by the alkalinity in the water, the alum reacting with the alkali in the raw water to form flocs of aluminum hydroxide. When the concentration of alkali in the raw water is insufficient to flocculate the alum, additional alkali must be provided. This is done by mixing lime with the water.

Volclay works in much the same way, but instead of a chemical reaction, bentonite particles, being negatively charged, are physically flocculated by the dissolved electrolytes. These electrolytes may be acid, base or salt, and flexibility is thereby added to the process. In the original research work, in the case of soft water and where an accelerated action was desired, lime was used, but it was also shown that the use of a small amount of alum—an amount too small for effective flocculation when used alone—greatly accelerates the action of the volclay, serving the same purpose as lime but packing a greater punch. However, it lacks the advantage of the softening effect found in lime.

During the experimental work at Watertown, both alum and sodium aluminate were tried as means of accelerating the action of bentonite. It was found that it took the same amount of aluminate as it did alum to bring the flocculation to the desired speed and as aluminate was the more expensive, it was eliminated in favor of alum. Various methods of application were tried—1st, adding the alum to the water and following it with bentonite; 2nd, adding bentonite first, followed by alum; and 3rd, mixing the two together and adding them simultaneously. It was found that this third method was most desirable, because the pre-flocculating effect of mixing these two concentrated dispersions of bentonite-water and alum-water, prior to treatment, brought about, when introduced into the raw water, the immediate appearance of a large, voluminous, rapidly growing and stable floc that could be broken up and re-formed an indefinite number of times, and each provide the same efficiency for turbidity removal. To complete the experiment the following procedure was adopted:

1. Disperse 2 grams of volclay bentonite in 100 cc water.

2. Make a solution of 2 grams of alum in 100 cc water.

3. Combine the two solutions in various proportions, such as suggested in the table below.

	Parts of 2% Volclay Suspension	*Parts of 2% Alum Suspension*
Combined Sol "A"	2	1
Combined Sol "B"	4	1
Combined Sol "C"	6	1
Combined Sol "D"	8	1

4. Add various proportions of the Combined Sols to

(Continued on page 36)

*Olin and Gouler—"Bentonite in Water Treatment." Journal A. W. W. A.—March, 1938.

The Editor's Page

For More Sewage Treatment and Less Stream Pollution

Three or four years ago, a campaign was begun to open the way for the elimination of stream pollution through Federal action. The final step—the passage by Congress of a law to enable national progress on a basis fair to all industries—has not yet been made, but this should be done during the present session of Congress.

This enabling legislation marks only the first step; the next one should be a campaign for the education of the public. Probably no other necessary governmental function has had less of popular interest and understanding. Sewage treatment is never popular; at the best it is recognized as necessary, and that, as a rule, only after local health authorities and state boards of health have cajoled, persuaded and threatened. Too many times even these have not been sufficient to induce the voters to approve expenditures for vitally needed construction. Sufficient proof of this will be found in a journey down almost any watercourse.

How should such a campaign of popular education be launched? Individual efforts are futile; a coordinated campaign is needed. The Interstate Sanitation Commission (New York City and vicinity) and the American Public Health Association have joined forces in an attempt to dramatize the need for proper sewage disposal. Industry must pay the bill, but it should reap rich rewards. The Commission has estimated that there are more than three thousand projects that should be carried out, the total cost of which is in excess of six hundred million dollars.

This plan for popular education is not yet complete as to details, but it is being projected on a broad and, we believe, a sound basis. It will be based largely on visual education on a scale never before attempted in the engineering field. It should help materially to create popular interest and understanding of waste disposal problems, and greatly to facilitate needed construction.

Comment, Experiences and Experiments

In the whole field of public works engineering, there is a tendency toward experimentation, and a feeling that improvements through new methods and new equipment are almost visible over the horizon. Being an editor brings one in touch with much of this experimental work; one realizes the need for an interchange of information and for facilities for a wider field of testing for new methods and new ideas.

We believe that the field of sewage treatment has been the leader in experimental work and in the development of new methods, equipment and processes during the past few years. Stirrings are more than visible in the highway and water fields. To encourage experimentation and development, this magazine wishes to act as an exchange medium for ideas, data and results. If you have been working out the answer to a problem in your plant, send us the results and sufficient of the procedure so that others may check your work. If you have had an interesting experience, send us that for the benefit of others.

Too many technical men are reluctant to publish their findings until these have been checked, double-checked and aged in the wood for such a long time that they are no longer of much value to others. As a matter of public service, a freer interchange of information is highly desirable. So send it on.

Keep a Good Thing When You Have It

In a letter accompanying a copy of the latest annual report of the Division of Sanitary Engineering of the Ohio State Department of Health, F. H. Waring, the chief engineer, says: "It is pertinent to state that the tremendous volume of work handled by this division is in a large measure accounted for by the fact that *no change in engineering personnel has been made during the last fourteen years* with the exception of the addition of two or three junior engineers selected by the writer. Without the whole-hearted cooperation of an efficient staff, this great volume of work could never have been accomplished."

Fortunate division and fortunate chief engineer—and fortunate State. Would that there were forty-seven others.—Then sanitation in this country would really "go places."

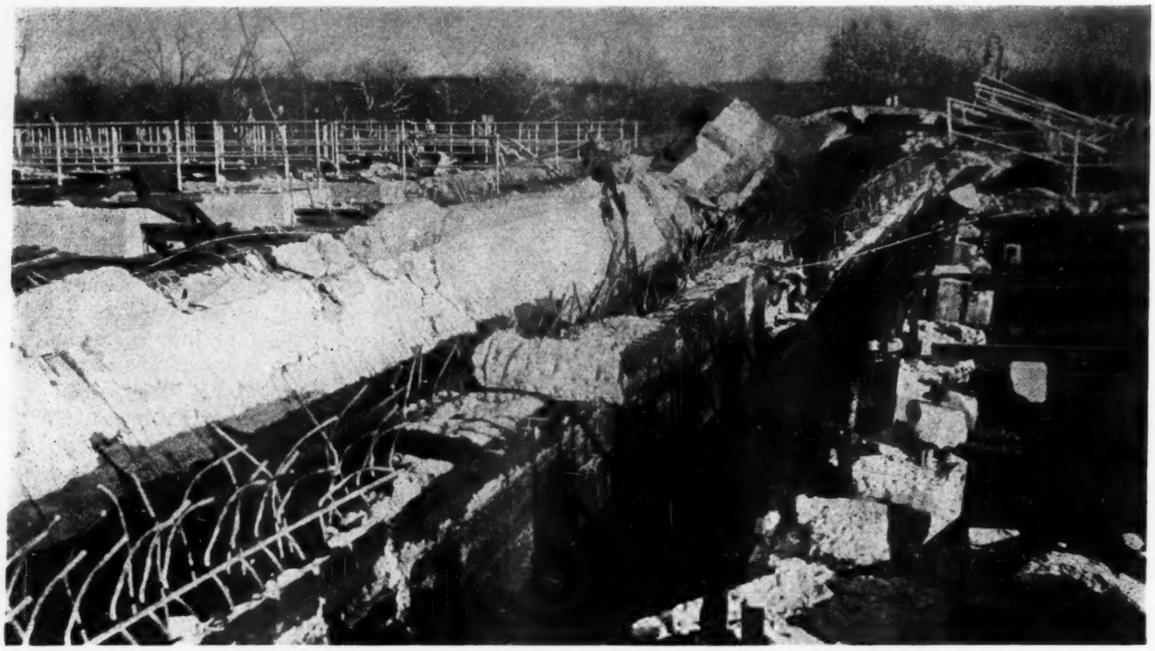
Maintenance Is an Important Part of Highway Engineering

In this issue begins an article on "How to Maintain Highways and Streets." It is intended to be a guide for the many thousand foremen, supervisors and engineers engaged in this work. The space that will be given to this article does not need to be justified; the importance of the work that these men do, and the present lack of any text or organized source of information for them is sufficient explanation.

An especial effort has been made to present detailed information, representing standards and practices that have been set up by the various states, larger cities and counties. Such detailed information is necessary if the material presented is to help very much in broadening the knowledge in this field.

We wish to acknowledge again the help that has been received from more than 50 men in the highway field. We hope that they, and others also, will help in making forthcoming sections even better. A project as large and as important as this needs all the help that can be gotten.

During the next six or seven months, the remaining material, outlined in the abbreviated table of contents on page 19, will be published. Comments, suggestions and criticisms from our readers will be welcomed.



Dayton Imhoff tanks after explosion, looking east along operating gallery.

Gas Explosion at the Dayton, O., Sewage Plant

Sewage gas is dangerous—it may explode; just as dangerous as the gas we all use in our kitchen ranges, but no more so. Reasonable precautions must be observed in using it, as well as in designing sludge digesting plants. The recent explosion at Dayton illustrates this.

THE Dayton, Ohio, sewage treatment plant, built in 1927, was seriously damaged on November 12 by an explosion in the enclosed operating gallery which took place at about 5.20 A. M., wrecking the gallery itself, the control houses and the machinery therein, and doing slight damage elsewhere. No one was injured. This gallery, 8 ft. wide by about 150 ft. long, lies between two banks of Imhoff tanks, was covered with a reinforced concrete roof and terminated at each end in a control house about 25 ft. square.

Metcalf and Eddy designed the plant, and E. Sherman Chase and Arthur L. Shaw, of that firm, at once went to Dayton to investigate the explosion. They made a personal investigation of the wreckage and interviewed members of the plant staff on November 13 and 14. Their findings are given below.

According to time card records, the night operator made his regular hourly rounds during the night and his last trip through the gallery was at about 4:30 A. M., at which time he observed nothing out of the ordinary. No one was in or near the gallery at the time of the explosion.

The Damage. The major damage took place in the operating gallery and in the control houses at either end through which access to the gallery was obtained and in which the main control valves were located. The reinforced concrete influent and effluent conduits which overhung the gallery at both sides, and the reinforced concrete slab which completed the roof of the gallery, were almost completely demolished. The brick walls of both control house superstructures were thrown outward, allowing the concrete roof slabs to fall down, resulting in considerable damage to the electrical sluice gate operating mechanisms, air compressors and other equipment housed in these buildings.

The lines of sludge, water and gas piping in the gallery were partially demolished and badly damaged. As the roof slab was blown upward, the pipe hangers which supported the main upper lines of pipe tore loose, permitting the pipes to fall carrying other lines with them.

Large sections of the gallery roof slab were hurled into the air and fell onto the upper works of the adjacent Imhoff tanks, breaking down some of the walkways and hand rails, and damaging some concrete at the tops of the gas vents; injury to the Imhoff tanks proper, however, was superficial.

Concussion and falling debris broke some 2,000 panes of glass in the sludge bed glassovers. A few windows were broken in the detritus and administration buildings and a few roof tiles were broken by falling debris.

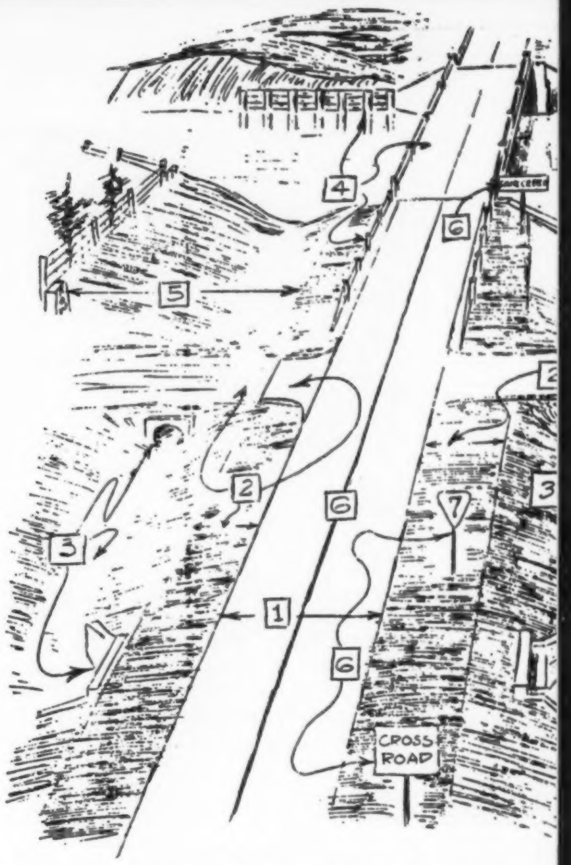
The Cause. There can be but little doubt that the explosion was the result of the ignition of sewage gas escaping in some manner from the system in which it is collected. Gas generated in the digestion compartments of the Imhoff tanks passes up into the gas vents, where it is collected in cast iron gas domes. The domes are connected to lateral pipes which are carried through the tank walls into the gallery and thence into a gas main running lengthwise of the gallery, which carries the

(Concluded on page 36)

How to Maintain Highways and Streets

Prepared by
W. A. Hardenbergh and Consulting Staff

This is the first of a series of five articles covering maintenance of highways and streets. Tentative scheduling of the remaining four articles is as follows: MARCH: Roadsides; structures; plant and equipment; handling and storing materials; earth and gravel maintenance. MAY: Maintenance of bituminous, brick, concrete and other surfaces. JULY: Soils in highway maintenance. AUGUST: Equipment and materials used in maintenance.



Key to nomenclature in this article: 1, the surface; 2, shoulders and side approaches; 3, drainage; 4, structure repair; 5, roadside; 6, traffic service; 7, other.

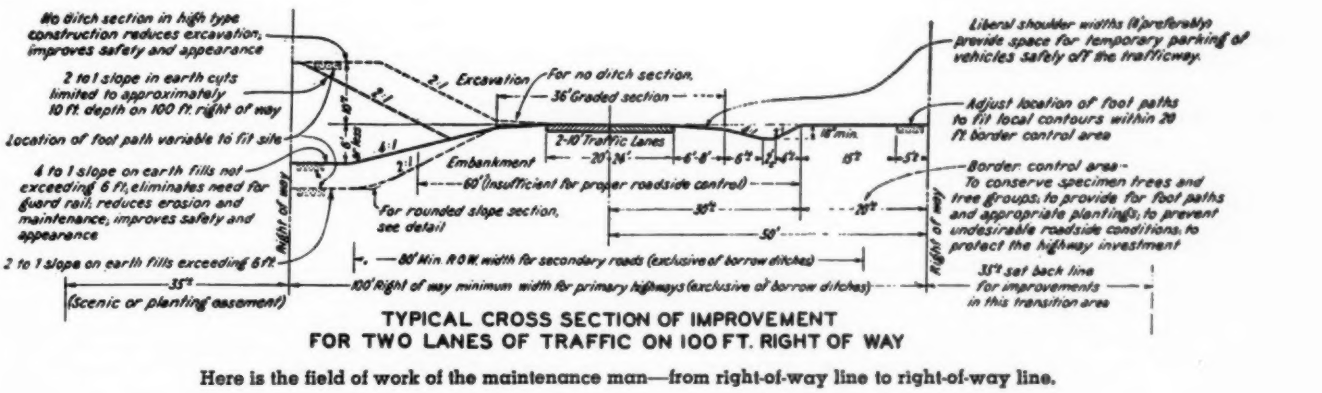
IN HIGHWAY work, maintenance consists of carrying out all of the activities and duties necessary to keep a road or street up to the last standard attained by construction or betterment work. Even though our highways are designed and constructed carefully, and often with an excess of strength in order to sustain the loads that may come upon them, yet they are astonishingly fragile. Without regular, skillful and systematic maintenance, the wear and pounding of traffic and the stresses that nature places on them through heat, cold and storm, combine to destroy their value in a surprisingly short time. A few years ago Thomas H. MacDonald, chief of the U. S. Bureau of Public Roads, said: "It is my estimate that the lack of adequate maintenance would be seriously noticed on 75% of our road mileage within 30 days; within six months we would be losing money so fast through depreciation and drop in gas tax revenues that we soon would not have money enough to take care of the fixed charges and maintenance alone. . . . Our whole improved mileage is absolutely dependent for its existence upon the day-by-day highly organized maintenance operations under experienced supervision and control."

The highway systems, in most states, constitute the greatest single asset of those states; and the same is true of most or all counties, cities, townships and villages. More money has been invested in highway construction by the public, through tax money and bond issues, than for any other public purpose. Expenditures annually are probably greater for streets and roads than for any other single purpose.

It is therefore a sound policy to conserve this great investment through adequate maintenance; in addition, it also keeps the highways in a safe travelable condition for the public; such maintenance makes possible the tremendous income from motor vehicle licenses and gasoline taxes.

These matters are so obvious and elementary that they should not need to be stated. They are presented here primarily to give the maintenance man a conservatively true picture of the great importance of his work, so that he may appreciate the need for constant improvement in his knowledge and technique, the utilization of good materials and the employment of proper equipment.

Maintaining a road or street almost always involves minor betterments or improvements, as well as simple repairing. In fact, these two forms of work merge so closely into each other that they are almost inseparable in practice. Few highway authorities agree exactly as to the location of the dividing line between maintenance and betterment, and the allocation of costs between them is very difficult. Much may depend upon the type of surface. A modern 4-lane boulevard is usually so highly engineered that betterments are practically impossible and only the minor routine details of shoulder and surface maintenance, grass and weed cutting, etc., are needed. A rural secondary road, on the other hand, may be bettered by widening slightly at the curves, improving intersections and junctions, installing



TYPICAL CROSS SECTION OF IMPROVEMENT
FOR TWO LANES OF TRAFFIC ON 100 FT. RIGHT OF WAY

Here is the field of work of the maintenance man—from right-of-way line to right-of-way line.

Patching is needed in surface maintenance.

needed subdrainage, etc., in addition to the routine work such as that needed on the superhighway.

So far as this text is concerned, no distinction will be made between maintenance and betterment; they involve the same general types of work for the most part, and the distinction is often one for the cost accountant, to be decided according to the practice of the local highway department.

Classification of Maintenance Work

Maintenance is sometimes classified loosely as light or heavy, the former including operations that are frequently or continuously required to keep the surface free from holes; the shoulders uniform, safe and clean; the ditches open; and the roadsides free from grass, brush and weeds. Heavy maintenance verges more closely toward betterments, but may also include such items as repairs after a washout; scarifying and rebuilding a wavy or rutted surface; widening or rounding out curves; lengthening culverts; widening ditches; and improving the slopes of cuts or fills.

A more exact classification is necessary for accounting and management purposes, and many of the state highway departments have worked out such data.[5] The major classes of maintenance work vary to some extent, and practices are not by any means uniform among the states or counties. The principal subjects under which all maintenance work will fall include: The surface or traveled way; shoulders, including side road approaches and intersections; drainage; roadside maintenance; structure repair; traffic service; plant and equipment; and handling and storing materials. A standardized classification has been prepared by the American Association of State Highway Officials.[2]

(a) *The Surface or Traveled Way.*—This normally includes the full width of the surface of the road, with the base, foundations, and subgrade, but not paved shoulders. Connecticut, however, includes improved shoulders on bituminous macadam, macadam, gravel and stone roads, but only the width of the pavement on concrete and sheet asphalt roads. The work under this head will include: Patching, which is the routine repairing and restoring of small broken areas in the surface; repairing blow-ups and raveled edges; and, in some cases, towing through mudholes and the work of making such areas temporarily passable. Surface treating and retreatments, spot sealing and treatment of bleeding surfaces. Pouring joints and cracks, including the removal of excess material extruded from the crack or joint. Base and sub-base repairs, including the repair or replacement of the material beneath the surface; and mudjacking, or the repair of uneven concrete slabs. It would also, naturally, include dragging of gravel or dirt roads and similar work.

(b) *Shoulders.*—According to the Connecticut Highway Department, the term "shoulders" means "On concrete, bituminous concrete and sheet asphalt pavement, that portion of the right of way between the edge of the pavement and the top of the inside slope of the gutter; or if there is no well-defined gutter, then to the inside edge of the roadside or that part of the right of way on which there is grass or vegetation; and on a fill, to the top of the slope."

In general, we shall consider the term to mean that portion of the road between the edges of the traveled way and the break to the ditch line; also the surface of side approaches from the shoulder line to the right-of-way intersection.

Necessary work on the shoulders, and to side approaches, intersections and junctions normally includes: Shaping of the shoulders; patching and replacing material removed by traffic or erosion; dragging, the addition of necessary material and application of non-binding material on loose types; original surface treatments and retreatments on bound-type shoulders; erosion control, as sodding, planting or seeding; and cutting down high shoulders, building up low ones and minor widening. In some cases mowing is placed under this heading; in others under Roadside Work.

(c) *Traffic Service.*—This includes the carrying out of the measures necessary for the safe and comfortable use of the road by the public. In some places, it is classed as "work on safety devices." It comprises: The installation, repair and renewal of all highway lighting, and of traffic, safety, warning and directional signs, including warning posts at narrow bridges or culverts and warning boards at turns and railroad crossings. The painting and renewal of guide lines for traffic at railroad crossings, curves, hills and other places; snow and ice removal and control; the use of magnetic sweepers to remove nails and other metal objects from the road; in some states, the control of truck loading and wheel weights; pulling cars through mudholes and snow drifts is, in some places, covered under this head.

In some cases, repairing and painting of guard rails are included in this classification, while in other cases, guard rail work is included under the heading of "structures." Barrier and work signs are more properly classed under "plant and equipment."

(d) *Drainage.* — This includes the maintenance of all facilities for controlling properly the flow of water, but it normally does not include structures of 20-ft. span or over. (This limiting length of span may vary in different areas.) Work under this head normally covers: Ditch work and repair, including the removal of debris from channels, channel changes, building of ditch checks, and other temporary means of erosion control in the ditch. Drains and sub-drains and their maintenance, including keeping open subgrade tiles, pipes and French drains. Repairing riprapping (except at abutments of bridges of 20-ft. span or more). Spillways; paved side ditches; and catch basins.

The work under this head also includes subdrainage construction (and maintenance) for the purpose of lowering ground water or intercepting ground water flows to prevent frost boils or heaving, and for providing a stable subbase to support the road.

(e) *Roadside Work.*—This classification will include that work done beyond the shoulders, except for drainage purposes, and will also include grass, weed and brush removal from the road shoulders. Grass and weed "cutting" includes removal by any method, as burning or removal with a grader or bulldozer. The removal of debris may include the clearing and removal of fallen trees, wrecks and broken advertising signs. Roadside development includes care and replacement of trees and shrubs, sod and other planting. Other work may include the shaping or stabilizing of cut slopes, the removal of talus or eroded material from slides or weathering; the reshaping of settled or slipped areas in fills; and the repair of slides and washouts. In some states, this division covers control of the location of sewers, water and gas pipes, public utility poles and other structures within the right-of-way, and control of tree trimming by utilities.

(f) *Structure Repair.*—This item will normally cover all work involved in the painting, repair and upkeep of structures of 20-ft. or more span; retaining walls; maintenance of gravel ballast and bituminous surfaces on timber bridge floors; and, unless otherwise classified (see traffic service), the painting and repair of guard rails.

(g) *Plant and Equipment.* — This term is normally meant to include lands, building equipment, highway machinery, automobiles, trucks, sand and gravel pits, small tools and barrier and work signs; in fact, all of the equipment owned by or assigned to the maintenance forces.

Of course, such plant and equipment items are factors in the overhead and administration of the maintenance work. They are necessary, to a greater or less degree, in carrying on the work of maintenance, though of themselves they do not represent problems of the work that is to be done. This item is perhaps more of an accounting or book-keeping one; nevertheless it is necessary in any well-regulated maintenance operation.

(h) *Handling and Storing.*—It is necessary to maintain a store of materials used in maintenance work—stone, gravel and sand; asphalt, tar and cement; salt and calcium chloride; paint; posts, rails and fastener devices for guard rails; and hundreds of other items, the number and importance depending upon the extent of operations. The storage loading,, trans-

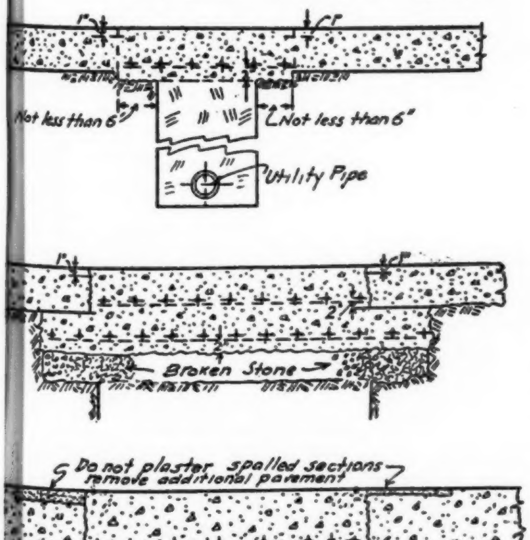
portation and placing of this material must be accounted for, and the amount of material on hand should be known. This item also, therefore, is largely an administrative and accounting one, but it is important and necessary that the maintenance foreman or supervisor understand the details and operation of this and of the preceding item in order that his reports and forms may fit into the general accounting scheme and show the proper allocation of costs to the various items of work.

Importance of These Elements.—The various elements in the preceding classification will vary in importance with many local conditions of soil, climate, weather, type of surface, amount and kind of traffic, etc. The Mississippi Highway Department, in its instructions to maintenance foremen, gives the following weights to the various items of work (omitting plant, equipment and stock): Surface, 40%; drainage and ditches, 25%; shoulders, 10%; major structures, 10%; minor structures, 5%; roadside cleaning, 5%; and traffic service, 5%. These are, of course, merely suggestions to the maintenance foreman for the division of time of his gang, and are subject to variation, as already stated, according to many local conditions.

Maintaining the Surface or Traveled Way

Patching Holes.—The most important item in patching a hole in a highway surface or pavement is to determine what caused the hole to form, and then to remedy that cause. If improper drainage was the factor that caused the break, adequate drainage should be installed; if a weak foundation or base was the reason for failure, this should be strengthened; if the failure was due to any other reason than a poor or inadequate surface, curative steps should be taken before the patch is applied.

Top, a patch over a trench; middle and bottom show procedure with poor subgrades.



A roadside set-up for Tarmac cold patch.

In patching, the affected area should be removed; also unaffected surface for about 6 inches around the hole. The edges should be cut sharp and vertical. Examine the condition of the base or sub-base. If there is a concrete or black base beneath the surface, follow the procedure for repair of bases outlined hereafter. Even if the old aggregate is to be reused, it is better to take it out entirely, prepare the opening, and then replace the old aggregate along with the new material required.

The depth of the patch determines pretty much the size of aggregate to be used in it. For a patch in a surface 1 inch thick, ¼ to ¾-inch aggregate should be used. For depressions or holes which, when cleaned out, are 2, 3 or 4 inches deep, 1¼ to 2-inch (or 2½-inch for the deeper holes) aggregate should be used. Before placing the patch material a hole should be cleaned thoroughly, and the hole and an area about 6 inches greater than the patch sprayed lightly or painted with bituminous material (except in a gravel, water or traffic-bound macadam or stabilized surface).

The filler material should preferably be that used in the original surface, or having the same characteristics. That is, if the original surface was constructed with tar, use the same grade or a similar grade in the patch; if of asphalt, likewise; if of stabilized material, use the aggregate, binder and stabilizing material in the same proportions as used in the original construction.

Aggregate may be placed, tamped or rolled, and sprayed with bitumen, covered, tamped or rolled, and sealed. Or a cold patch may be used. Details of this procedure will be given for each type of pavement. In this section, the importance of determining the cause of failure, the proper preparation of the edges, the necessity of cleaning, and similar factors which are necessities common to all patches, are meant to be stressed.

Repairing Cuts.—Cuts in paved surfaces are often necessary and frequently made. While these are probably more common in city and village streets, due to water and sewer connections, repairs or extensions, and to power and telephone ducts, openings are also made in rural highways for many purposes. In most places, such cuts are made only by permit, and under regulation; but the maintenance employee has little to do with this. His job is to repair such openings. And this work should never be delegated to the plumber, water department, or power or telephone gang.

In the repair of cuts in concrete pavements or pavements having a concrete base, there are three essential elements which must be given full consideration. These are: 1, the material beneath the base; 2, the base; and 3, the surface.

For general work the concrete mix should range between 1:1½:2 and 1:1¾:3½, the former mix being used for patches averaging two square yards or less, wherein a "three-quarter inch" coarse aggregate is preferable, and the latter for patches exceeding three square yards, in which larger aggregate should be used. Whatever mixture may be determined upon, it is essential to slightly increase the cement ratio in the composition of the repair section. This increase may be fixed at ten per cent, although during summer temperatures where admixtures are used flash set should be closely guarded against. Where the original composition of the pavement being repaired is known, the same mixture may be used in large repair sections.

Over trenches the concrete should be removed for not less than six inches beyond the edge of a trench. The subgrade so exposed, if of the proper stability, should not be adjusted in any manner. Where doubt exists as to the quality of the underlying foundation the surface of the subgrade adjacent to the trench should be removed for a sufficient depth to secure a substantial support.

The backfill placed in the excavated trench must be thoroughly compacted by either flooding or mechanical tamping, carried out in layers not to exceed four inches thick where possible. Best compaction is obtained with stable mixtures of sand and clay, or of graded aggregate

and clay, of the proper moisture content.

The edge of the concrete along the outside of the cut should be rough and uneven (the top inch may be cut smooth). An edge cut smooth for the entire depth may "punch out."

When the material removed from the trench is not suitable for making a firm backfill, it should be wasted and the backfill made with good material. With sand and gravel subgrades, consolidation by puddling is frequently used. Water may be added as the trench is filled, or applied at the top after filling with earth. The former is the better way. As the water drains out, the solid backfill remains. This method is not generally used in clay soils, from which water drains so slowly that the trench contents may remain in a semi-liquid condition for a long time.

With clay soils, the best method is to place the backfill in thin layers (3 inches to 5 inches) and ram each layer, either by hand rammers, or by air or explosion type tampers. For the best compaction, the earth should be slightly moist, but not wet.

In either case, lumps over about 2 inches in size should be broken up and frozen dirt or soft mud should not be used for fill. If stone or rock particles are used in the fill, dirt should be tamped thoroughly around them so as not to leave openings that will cause settlement later.

Placing the Concrete.—If oil has penetrated the old concrete for a considerable depth no adhesion of the old concrete can be expected, but a rough abutting edge will tend to hold the patch in position.

Spalled or scaled surface areas of the old concrete adjacent to the edge of the cut should not be plastered, as such shallow repairs will chip out quickly. In such cases it may be necessary to cut back the entire depth of the concrete under súch spalled areas.

Reinforcing steel, preferably three-eighths inch diameter deformed, should be placed in the restored section two inches above the bottom of the slab. The amount of such reinforcement will depend upon the dimensions of the opening being repaired and upon the conditon of the subgrade. In general the spacing should conform to the spacing in the old pavement, both transversely and longitudinally. Where reinforced pavements are encountered the existing reinforcement in the area of the repair should not be removed, but should be bent out of range of repair operations until the section is to be replaced, at which time the steel should be returned as nearly as possible to its original position and tied in with new reinforcement. Where unreinforced pavements are encountered a mat of bars not more than twelve inches center to center should be placed. Such reinforcement is important in restoration over service trenches. In case of extra-depth patches, two lines of reinforcement may be used.

Placing Concrete Mixture.—The edges of the existing pavement should be thoroughly washed, wire brushed, wetted down and painted with a one-to-one mortar coating immediately previous to the placing of the concrete mixture. This treatment is essential at all times, but more so with high summer temperatures, during which periods the edges must be completely cooled and saturated previous to the mortar coating, to be followed immediately by the installation of the concrete mixture.

Plain Concrete Mixture.—The water content of any plain mixture should not exceed four gallons per bag of cement, less the moisture content of both fine and coarse aggregates. During certain periods of the working day a stock pile of either fine or coarse aggregate may contain much more water at the bottom than in the top and this condition must be carefully watched and the water added at the mixer drum adjusted accordingly.

The aggregates should be mixed from not less than two and one-half minutes to five minutes in a machine mixer. No hand mixing methods should be employed. The resultant mixture should flow from a square-pointed shovel with difficulty. The four-gallon water-cement ratio mixture will, as a rule, produce a consistency which is called "unworkable." This mixture should be placed in the repair area in two-inch layers, each layer being compacted by either manual or mechanical manipulation, the compacting being completed before initial set takes place. The final "dry" layer of concrete must be tamped sufficiently to bring out a workable surface, roughly planed and kept slightly above the finished grade. The final tamping and finishing of the surface should be done as late as possible so that the shrinkage of the concrete may be worked out prior to the time of setting up. This procedure at a late period is necessary to provide a good bond.

Repairing Wavy Surfaces. — Wavy surfaces may be caused, in bituminous pavements in one or more of the following: by failure to remove all the dust and fine dirt before applying a surface treatment; by the use of a mix that contains too much or too soft bitumen; or from other causes. Such surfaces if of road-mix or surface treatment type, can be corrected by scarifying the surface, rebladíng and consolidating, followed by the application of a surface treatment. Shaving off the tops of the waves or corrugations with a blade grader or other equipment is ineffective, unless done as a preliminary to placing a new surface treatment or other wearing course.

On brick, a wavy surface is an indication of failure of either the base or the bedding course; taking up and relaying or patching or filling the depressions with bituminous paving materials is indicated. Concrete slabs are wavy when the subbase has settled unevenly. Drainage and reconstruction or mudjacking are indicated. More detailed data will be presented under the various pavement types.

Raveled and Broken Surfaces.—The extent to which the surface needs repair will generally determine the method of repairing. The first step is to determine this. A surface that has 3% or 4% of its area broken or raveled looks, as a rule, to be in much worse condition than it really is. Therefore a critical examination may be needed to show the exact condition of the surface. Raveling is often caused by deteriorating effects of moisture, sun and air on the surface course. If the base is good, correct by retreating with bituminous material or resurfacing by applying bituminous mixture.

If the breaking and raveling extend over long stretches, patching and spot treatment should not be attempted. The cause of failure should be determined and corrected, if this cause is something else than the methods or materials used in building the surface. After the cause of failure has been been determined and corrected, the old surface should be scarified and, using the orginal materials, enough new material added for a retreatment. Patching and spot treatment are largely hand processes; scarifying and resurfacing are done by equipment, and are therefore cheaper. And when repaired in this way, the final appearance is uniform and smooth.

Grade Crossing Maintenance. — The obligation for maintaining that part of a railroad grade crossing within right-of-way limits is normally imposed on the railroad company. The highway department's duty is to see that the obligations of the railroad company for taking care of this area and keeping it in good condition are fulfilled. The maintenance foreman or supervisor should report on the condition of all crossings.

Where the protective devices at the crossing are under the control of the state, city or county, the maintenance forces should report faulty operation or other defects to the engineer; and where such protective devices are badly needed, but absent, this also should be reported.

The maintenance forces have no right to change the level of the rails and should make no repairs on the railroad right-of-way. Likewise, the railroad company should not change the elevation of the rails so as to impair the crossing, without notification to the highway department.

The Ohio Highway Department has adopted the following standards for crossings: (1) Crossing pavements (between outside ends of ties and where there are no sidewalk requirements) should be two feet wider on each side than the adjacent pavement to afford extra leeway for the driver; (2) Where practicable, approach grades to crossings shall not exceed 2% within 50-ft. of the near rail; (3) Highway grades shall meet rail elevations without a break in grade, care being taken that the same condition applies to pavement edge grades where a skewed crossing exists; (4) Where possible, curved alinement across tracks should be avoided unless the superelevation of the tracks and of the proposed highway superelevation can be made to coincide; (5) Flasher lights, wig-wag signals or other devices for warning, unless suspended over the highway, should be set a minimum of 2-ft. clear of the pavement.

Routine maintenance work will include the repair of defects near grade crossings, the improvement of sight distances wherever possible, and the discouragement of erection of any objects near the crossing

which may tend to increase the accident hazard. These may include objects that block the view of the crossing or those that attract the attention of motorists away from the crossing.

Graders, drags and other equipment should be operated so that material will not be pulled onto the tracks. Loose gravel, earth, sticks, stones, etc., should be removed from the crossing (whether deposited by the maintenance forces or not) and the grooves between the rail and the planks or other material used for the crossing should be cleaned out completely and carefully. Road material wedged into the grooves or lying over the rail may cause derailment. Snow plow operators should also remove packed snow from the grooves between the rails and the surfacing, as such snow may turn into ice and has been known to cause derailment.

Frost Boils and Frost Heaving.—Frost boils and heaving by frost action are, in reality, a drainage problem. The cure in the majority of cases is the installation of proper subgrade drainage, though there are palliative measures that may be employed. Frost boils occur in any type of surface, if subjected to long and severe cold spells, when there is an excessive accumulation of water in the subgrade. The character and composition of the soil is important, in that it is the controlling factor in collecting and holding the water. The volume and weight of traffic affects the damage to the surface, in that heavy traffic will break up the road surface more than lighter traffic.

The primary cause of frost heaves and boils is probably capillary water. In finely divided soils, as silts and clays, this capillary water probably does not freeze at ordinary winter temperatures, but is attracted to ice particles that do form near the bottom of the surfacing or base, and freezes at it reaches this ice. The capillary water, as it is added to the ice beneath the surface, is replaced, by capillarity, from free water below. The amount of heaving, that is, the thickness of the ice formation—depends upon the rapidity with which the capillary water is supplied. Silts afford the most rapid passage for capillary water; clays transmit water slowly, but have a high capillary lift; sand has a low capillary lift and will not, therefore, raise water for any appreciable distance.

The upper layer of the soil immediately under the road thaws first in the spring. At frost heave locations, the melting ice pocket forms an accumulation of water that cannot drain away because of the frozen ground underneath. The subgrade is made plastic by the water, and the lack of support for the surface may cause it to deflect or break under traffic. In either case, the churning and mixing action of the water and soil increases the size of the area of trouble, and of the pavement failure.

The cure for frost heaves and boils lies in preventing the capillary water from rising to the surface of the subgrade. This may be accomplished by lowering the ground water to such a level that capillary action will not bring it up to the subgrade level, or by cutting off the flow of ground water under the road and thus eliminating the source of capillary water. Methods of constructing subdrains to accomplish these objectives will be discussed in detail in the section on "Drainage." In general, such construction should be designed to make it easier for the water to reach a drain than to rise to the subgrade; even if such drainage is only partly effective, the amount of water that will rise is so reduced that the heave or boil will be small and limited in extent.

In some types of soils, capillary attraction will raise water remarkable distances —as much as 20 feet. Sand and gravel (especially the latter) have very low capillary lifting power. Therefore, a layer of such granular material placed under the pavement or surfacing will prevent the rise of the water above the bottom of the granular layer. Any thrust from the formation of ice will be distributed over a wider area; and the granular material gives added supporting strength to the surface; also it reduces the tendency of the soil in that area to turn into liquid mud without supporting strength. When a cutoff layer of such granular material is used, drains should be installed to remove such water as may collect in it.

Some work has also been done in utilizing a bituminous blanket or layer under the subgrade, the purpose being to interpose an impervious stratum to prevent the rise of the capillary water. With a grader, the road is cut to a depth of 12 inches or more (in some cases to a depth of 2 to 3 ft.), the material being turned back on the shoulders. This exposed surface of the subgrade, and also the sides of the cut section in unfavorable soils, is then waterproofed with an asphalt or tar treatment or membrane, the surface material bladed back, and the surface compacted in layers of proper depth. Or if the material in the cut is a silt of high capillarity, an entirely different material may be used for backfill. The formation of ice particles is thus forced to occur at a greater depth and the thicker layer of material above gives greater bearing strength to carry traffic over such spots. Drainage should be used to supplement this type of construction.

This section should be read in connection with those on "Drainage" (to appear next month) and on "Soils" (to appear in a later edition).

Responsibility for repairing the damages to surfaces caused by frost boils usually lies with the maintenance organization; but preventive measures, as the installation of adequate drainage and the construction of granular layers or bituminous membranes, in most organizations, must be authorized by the maintenance engineer in charge.

Palliative measures to reduce the severity of the boil or heave are not usually very successful, nor will they prevent the recurrence of trouble in the future. Therefore, principal reliance should be placed on well-planned work to eliminate future troubles by proper drainage and such other construction as local conditions demand. In preparation for such measures, maintenance forces should locate frost boils and so mark the areas that they can be located accurately afterward for desired repair or prevention work. Full notes of each heave or boil should be made for future reference. Photographs help in showing the conditions. A study should be made with a view to the installation of drainage or other control means.

The measures that are sometimes used to reduce the severity of the trouble during the spring include: (1) Blasting, in order to break up the impervious area beneath and allow the water from the melting ice particles to drain into the soil underneath. (2) Thawing through the frozen soil with a steam jet, also to permit drainage. Both of these are of uncertain value. The soil may be so dense and impervious beneath the road that water will not drain downward into it even when the frozen area is opened or destroyed. In fact, the very conditions that cause the rise of capillary water are unfavorable to rapid drainage in this manner. Calcium chloride has also been used to thaw drainage holes through the frozen layer, being inserted through an auger hole in the

Scarifying, reblading and rolling is often the best procedure on wavy surfaces. (Courtesy Caterpillar)

thawed layer. A fourth method of correction, is to fill the hole with gravel or stone. This is only an effort to repair temporarily the damage that has been done and to make the road passable for traffic. When followed by compaction and the repair of the surface, the trouble is remedied for that year; but the basic causes of trouble have not been removed and the difficulty can be expected to recur every year, if conditions for it are favorable.

Areas that are dangerous to traffic, as heaves, boils, depressions and bumps, should be plainly marked with a warning sign placed an adequate distance from the damaged area.

Filling Cracks and Joints.—This procedure is normally classed as "Surface Maintenance," but details of crack filling varies somewhat with the type of pavement or surface; and joint filling is restricted primarily to cement concrete pavements. Therefore, data on crack filling and repair will be given under the various surface types; and joint filling and related work under cement concrete. Fillers for brick and granite block pavements will be discussed in the sections devoted to these types.

Surface Treatment.—A treatment of this subject will be given under the general head of bituminous surfaces, and details of application to particular types under those headings.

Base and Subbase or Subgrade.—The method of repairing a base that has been cut through has already been described. Repairs for a base that has failed under traffic are of essentially the same nature. The area under the base should be examined to determine if its condition contributed to or caused the failure. A soft spot, a large stone or rock, soil that will not compact, springy or spongy soil, or similar cause may be responsible. The condition should be corrected by removing the cause and refilling the area with moist soil, gravel or sand — preferably material of the same general nature as in neighboring satisfactory areas—and compacting this in layers of 6 or 8 inches.

All affected areas of the base should be removed; also for a few inches beyond, to make sure that sound material is reached. The edges of the hole should be cleaned thoroughly and the hole repaired. The surface should then be replaced as previously described.

The directions given refer especially to concrete bases, and with them it is desirable to ram the new concrete back under the old, as shown on page 21 for cuts in pavements. However, the same procedure applies to all types of surfaces, as macadam, gravel and brick or bituminous pavements not on concrete bases. The condition that caused the failure should be located and corrected, and the surface then replaced as directed under the section on patching: In general, essentially the same materials should be used for repair as were originally used in adjacent satisfactory portions of the road.

Details of Shoulder Maintenance

There is some variation in the classification of "shoulders" among the various states, and this classification may also vary with the type of surface, as in Connecticut. A good general definition is that of Mississippi: "That portion of the road between the edges of the traveled way and the break toward the ditch line." The more modern method of employing a smooth slope from the edge of the traveled way to the ditch may make the exact location of the "break" difficult at times.

The higher speeds of motor cars make more substantial shoulders necessary. Ohio says that pavements with more than two lanes will not require shoulder material; 20-ft. 2-lane pavements carrying over 2,000 vehicles per day will generally require shoulder material; but with less than 2,000 vehicles daily a limited amount only if the traffic is wide and heavy; pavements of less than 20-ft. width will require shoulder material for a width on each side of about 18 ins., or sufficient to give an overall width of surface plus hard shoulders of slightly more than 20-ft.

Earth Shoulders. — Earth shoulders should be maintained as nearly as possible in the shape in which they were constructed and turned over to the maintenance forces; that is, reasonably smooth for occasional traffic use and flush with the pavement surface. This refers primarily to hard-surfaced roads with earth shoulders; on earth roads, ditching, preparing the shoulder and smoothing the surface is often a succession of related and consecutive operations.

To keep earth shoulders smooth and flush with the road surface, they must be shaped and graded from time to time, either by a grader or by hand. Where the roadsides are not improved, a grader can bring material up from the ditch, or obtain it by cutting into the bank. This can be spread and compacted to form the desired shoulder section. Where the roadsides have been improved and planted, material for repairing washouts and cave-ins must be hauled in, and placed and smoothed by hand. Compaction can be done economically by means of a light roller, 5 tons or more.

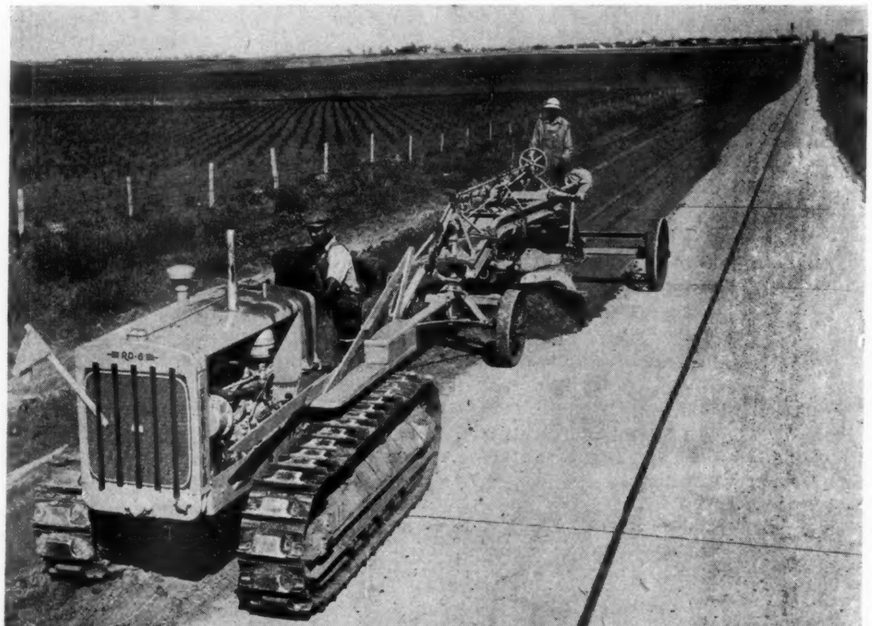
As in all maintenance work, the cause of damage, as by washout and/or slide, should be ascertained and remedied, if possible, and preventive measures taken. If damage is caused by an unavoidable washout, the destroyed area can be built up with stone fill and dirt, or surface treated.

Improved Shoulders. — Reshaping of shoulders that have been surfaced is normally necessary only when there has been a washout, cave or slip. In such cases, the process of repair should, whenever possible, include measures to prevent or minimize similar subsequent happenings.

Other work on improved shoulders will include patching and repairing holes, surface treatment, betterments (as turnout and parking places), seeding, etc.

Local material for shoulder maintenance should be used whenever possible, as it is generally available locally and usually costs less. For grades under 5%, Ohio recommends 1-inch maximum aggregate; coarser for heavier grades. Material should be readily compactible; crushing of material improves stability because of the interlocking of the fragments. Ohio states that where the price differential between graded and ungraded material is not large, the former should be used.

Repairing Holes.—Whenever holes or depressions occur in a shoulder, sufficient in size to endanger traffic or produce a rough surface, they should be repaired.



Keeping shoulders flush with surface is important (courtesy Caterpillar).

The hole should be cleaned, the edges made vertical, and the patch material placed in the depression and tamped or rolled into place so that it is at the same elevation as the adjacent shoulder surface. Larger holes and ruts may be filled with earth, sand, aggregate or other suitable material and surface treated.

The surfacing normally used on shoulders is not as thick nor as carefully placed in regard to base as that on the road surface, therefore once the shoulder has started to break or ravel, disintegration is likely to be more rapid. For that reason, failures on improved shoulders should be repaired promptly.

Surface Treating Shoulders. — Earth shoulders are not normally surface treated; improved shoulders on narrow, heavily traveled sections and on the inside of curves may be oiled or surface treated to give a depth of at least 3 ins. In advance of the work, the surface should be dressed carefully to the desired grade; rough or wavy spots should be repaired and smoothed. The same general procedure as used in surface treating highways is employed. (This will be described in detail in a later installment.) The surface is swept clean, a priming coat of bituminous material placed, stone chips or sand added, another bituminous application made and the cover material placed and rolled. The spray bar of the bituminous distributor should be shielded so that it will not drip on or mar the road surface. Stabilized soil-aggregate mixtures also provide satisfactory shoulders.

Details of Shoulder Maintenance. — Shoulders should be maintained flush with the edges of the pavement or surfacing, so that the water from the road surface will drain off to the ditches. High spots keep the water on the road surface; high spots at low grades may form a puddle that is dangerous to traffic and injurious to the pavement. Also, by concentrating the water in one spot, the tendency of the shoulder to erode is greatly increased. Ruts and depressions in the shoulders should be smoothed out, both to keep the shoulder smooth and to prevent ponding of the water on the shoulder.

This work is best done with a blade grader, making long smooth cuts. Cutting through a high shoulder with a trench that is only one shovel wide, will remove the water standing on the road; as a temporary expedient, it may be permissible, but it increases erosion of the shoulder. When using the grader, sod on self-draining grades should not be disturbed, as grass prevents erosion. High spots should be cut back, low spots filled in, and the shoulder brought to a slope of about ¾ to 1 inch per foot, gradually increasing as it nears the ditch. Special attention should be paid to the junction of the shoulder and the surface of a low-cost road. If possible equipment should be adjusted to do the complete job in one trip, but a ridge of material on the edge of the pavement should not be permitted.

Intensive shoulder maintenance should be planned for the fall and winter, before freezing occurs. Shoulders that enter a freeze in good condition are not likely to cause trouble. Intensive shoulder maintenance should also be planned for the period when the frost is leaving the ground. Shoulders that are in good shape in the early spring permit easy, first-class maintenance during the summer (Ohio).[4]

After cleaning the ditch, the sod is removed (Courtesy Cletrac)

Grass and Seeding.—The growing of grass should be encouraged, as it reduces erosion and also maintenance. Ohio lists desirable places as follows: On shoulders in all places outside of the requirements of traffic, and on slopes adjacent thereto; in cut and fill sections where it is necessary to check wash; and in all cases where the section passes from cut to fill.

On those sections, where grass is to be grown, the proper shape of shoulder should be provided and maintained while the grass is being established. New material that is added to these sections must be of such a character that it will grow grass. If grass is to be sown, the area should be carefully prepared. Seed mixtures most desirable to use depend on local conditions, as does the proper planting time. Fall planting is generally considered best, and at least six weeks' growing time is required to establish grass thoroughly. Since sod increases the height of the shoulder quite appreciably, the shoulder should be cut down before planting. The amount of increase in height depends on the quality of the sod. A very thin seeding will increase the height very little; a thick and heavy sod an inch or even more.

Berms along the shoulder are desirable on fills subject to erosion. These concentrate storm water flow to a special outlet. Further discussion of these will appear in the section "Roadside Improvement" in the March issue.

Vines are sometimes used for shoulder cover. This subject will be covered more thoroughly in the section on roadside improvement.

Minor Betterments.—As a safety factor it is important to encourage parking off the traveled roadway. This is especially the case where there is an interesting view, at places where water is available, at places where there are desirable picnic areas, etc. Turnouts and along-the-road parking places, which are desirable at intervals of not more than one mile, can be provided by placing culvert pipe in the ditch and filling to widen the roadway. Such places are often available where curves have been widened or eliminated. (See also the section on handling and storing.)

Cross Roads, Side Roads and Intersections.—Cross drains that are on side roads, but within the right-of-way limits of the main highway, are normally considered a part of the drainage system of the main road. Similarly, it is often or usually the case that the side or cross road itself is considered a part of the main highway to the limits of right-of-way, and is maintained up to these limits on both sides.

Side roads require attention because they may create a nuisance or dangerous condition because of dust, or traffic from them may deposit mud on the main road. This detracts from its appearance and may cause skidding. Therefore, it is customary to surface with gravel, stabilize or oil-treat the road back from the intersection, both ways for from 30 to 300 feet, depending on local conditions. In general, approach or side roads entering main roads, should be paved with the same material as that on the main road, back at least to the right-of-way line.

These roads, and also private roads, should be so graded that water from them will not run out on the surface of the highway. The shoulder of the main highway should generally have the same slope at the entrance of a cross or intersecting road, as far back as the break to the ditch line, as it has on each side of the entering road. Sufficient drainage should be provided. In many localities, the highway department will install free, and maintain until it becomes broken or unusable, a drain or culvert furnished by the owner of a private road. Where such private roads are of high-type surfacing, as concrete or asphalt, a permit is required for connection to the surfacing of the highway, the maintenance engineer determining grade, slope, layout and other characteristics before granting the permit.

Cutting back slopes so as to eliminate after slumping. (Courtesy Cletrac)

Drainage from the Highway.—In general, the water that falls on the highway must be discharged onto adjacent private property. No landowner has the right to drain to the highway more water than would naturally be drained by the adjacent lie of the land. Similarly, the highway department cannot concentrate water and discharge it at such a location or in such a manner as to cause damage to private property. Drainage must be so taken care of that there will be no ponds, dangerous ditches or interfering drainage structures. Highway employees do not generally have the right to clean ditches on private lands without special instructions and permission. In cleaning ditches that convey water from the gutters onto private lands, permission to clean them having been granted, dirt should be so disposed of that it will be neither unsightly nor a nuisance to the landowner.

Mail Boxes. — Mail and paper boxes (as for residents in rural sections) must be so located that they will not interfere with traffic or with maintenance operations. They should not be placed on guard rails or fences or similar structures. Where there are a number of them close together, they should be uniform in appearance and kept uniform as to height and line.

In some places, the Post Office Department requires that residents have two boxes, one on either side of the road, so that the carrier will not have to cross the road (with a left turn) to deliver mail. This is not generally enforced in isolated sections where traffic is light. The Fourth Assistant Post Master General determines where this ruling will be enforced, and questions should be referred to him. The Highway Department will find it advantageous to contact the postal authorities for general assistance in this phase of work.

The location of mail boxes is of considerable importance from the maintenance viewpoint due to the cutting of the shoulders and roadside in wet weather. Where residents can agree, several boxes can be located at one point, where the road can be widened and the surface of the widened area built up with a light all-weather surfacing.

When the Highway Department feels it necessary that boxes be moved, the owner should be notified in writing, with specific suggestions for improvement, and with ample time for action.

Traffic Service

This includes all the work necessary for the safe, convenient and comfortable use of the highways by the traveling public. Under this heading may be grouped the installation, repair and renewal of all safety, warning and directional signs, placing traffic lines or markers at railroads, curves, hills and other places, snow and ice removal or control, guard rails, and certain other work, including information regarding condition of roads and detours.

Guard Rail

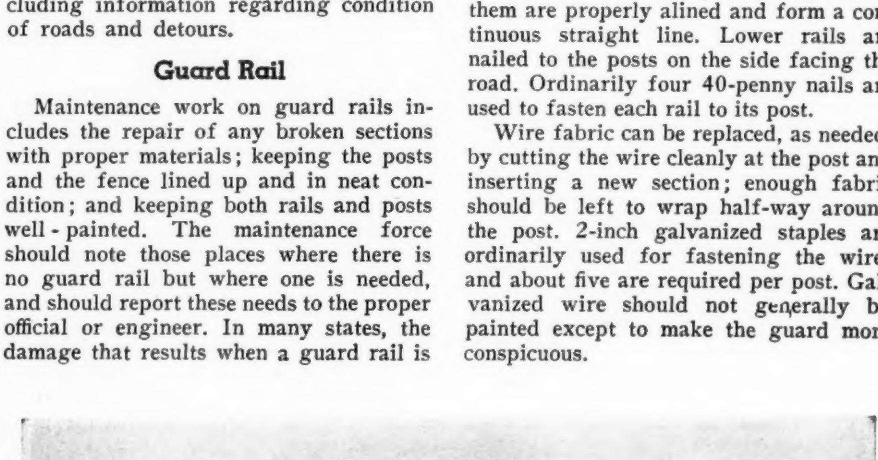
Maintenance work on guard rails includes the repair of any broken sections with proper materials; keeping the posts and the fence lined up and in neat condition; and keeping both rails and posts well-painted. The maintenance force should note those places where there is no guard rail but where one is needed, and should report these needs to the proper official or engineer. In many states, the damage that results when a guard rail is struck by an automobile or truck is charged to the owner of the vehicle. In such cases, the maintenance organization may have to find out who was responsible, and then appraise the damage, which should be based on the age and condition of the guard rail and the actual cost of replacement or repair.

Repair and Replacement.—Portions of guard rails that are rotten or rotting, weak or incapable of deflecting vehicles back into the roadway, as they are intended to do, should be promptly replaced. This applies also to the posts, since if these are weak, the rail cannot resist the impact of automobiles. Replaced portions should be of the same type and material as the original, in order to maintain a neat and uniform appearance.

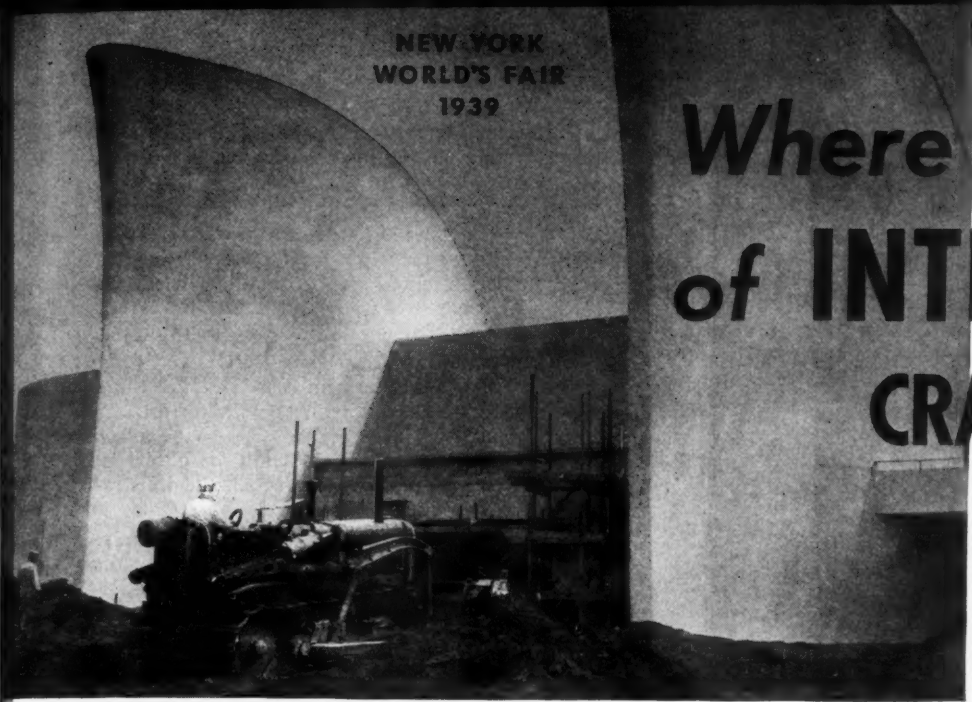
When considerable stretches of guard rail require replacement, it is not ordinarily economical to do this with the maintenance forces, piecemeal. It is better then to take up with the engineer in charge the desirability of replacing the entire section with a more modern type.

In the case of wooden guard rails, special attention should be paid to keeping the wooden rails closely butted to each other, and fastened in place securely. A splintered or split rail should be replaced, unless it is possible to repair it securely. The bevel on posts, where wooden rails are used, is ordinarily about 12 horizontal to 7 vertical, and special care should be taken to see that all tops and the rails on them are properly alined and form a continuous straight line. Lower rails are nailed to the posts on the side facing the road. Ordinarily four 40-penny nails are used to fasten each rail to its post.

Wire fabric can be replaced, as needed, by cutting the wire cleanly at the post and inserting a new section; enough fabric should be left to wrap half-way around the post. 2-inch galvanized staples are ordinarily used for fastening the wire, and about five are required per post. Galvanized wire should not generally be painted except to make the guard more conspicuous.



Shovel dressing a Virginia road shoulder.



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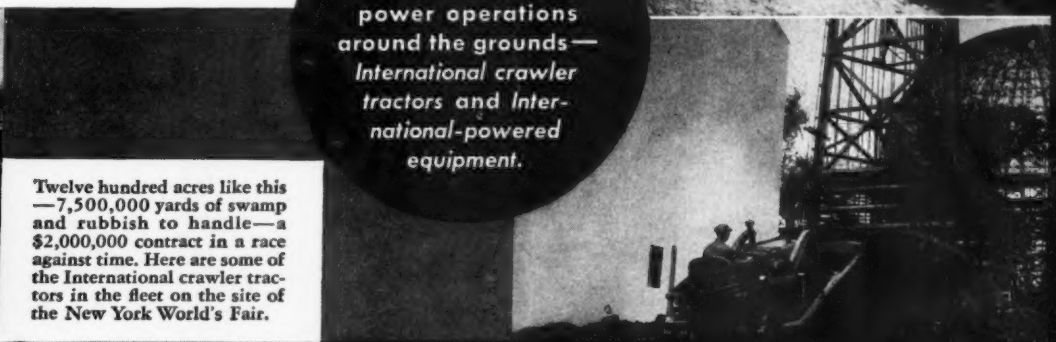
At right and above: A few of the many industrial power operations around the grounds—International crawler tractors and International-powered equipment.



Twelve hundred acres like this—7,500,000 yards of swamp and rubbish to handle—a $2,000,000 contract in a race against time. Here are some of the International crawler tractors in the fleet on the site of the New York World's Fair.

INTERNATIONAL INDUSTRIAL POWER

A good guard rail installation.

When cable guards are broken, the length of cable is ordinarily completely replaced; at times, it will be cheaper to construct an additonal set of dead men and re-use some of the existing cable. Dead men for cables (one must be constructed at each end of each set of cables) should have an area of at least 4 sq. ft. and should, if possible, be located in undisturbed material. Tightening is by means of turnbuckles, and the maintenance forces must adjust these to the temperature—very tight in the winter, and looser in the summer. Cable rails should be placed so that there is the same length of post above the cable on all posts. The top of the post should be cut at the 12 horizontal to 7 vertical bevel. Where the cable is fastened by bolts through the post, the bolt holes should not be drilled until after the post has been set. Anchorages should be placed at distances of not more than 500 feet.

Posts on all guard rails should be set firmly in solid ground, if this is possible; the bottom of the hole may be rammed to insure a solid foundation; backfilling around the posts should be placed in thin layers and rammed.

Painting. — Guard rails and posts should be kept well painted, both for their preservation and for better visibility. Paint should not be applied when the surface is damp, nor in foggy, rainy or freezing weather. When repainting, the surface should be thoroughly cleaned with a wire brush or by other means. The second coat should not be applied until the first is completely dry.

That portion of the post below ground, and for some distance above—6 to 12 inches—should be creosoted or painted with a wood preserving paint. The portion above ground should be painted white, except that it is difficult to keep the portion close to the ground clean, as mud or dirt is spattered up by rain; therefore, it is common to paint the bottom portion of the post, to a height of about 8 to 12 inches above the ground, black and the remainder of it white. When posts have been creosoted, a priming coat of aluminum paint should be applied.

Location of Guard Rails.—Guard rails should be located along all dangerous embankments and at all bridge approaches. The observation and judgment of the maintenance forces will be useful in determining guard rail needs at various embankments which are on the borderline.

The posts supporting guard rails must in turn have adequate support. There should be at least 12 inches of shoulder outside of the center of the post, and the slope of the shoulder should not exceed 1½:1. Where fills or shoulders have eroded or washed so that the posts no longer have adequate support, they should be rebuilt to the proper cross section.

Green fills, until they have been protected by guard rail, should be marked with a row of culvert markers or posts set not more than 50 feet apart.

Warning or Culvert End Markers

Warning posts are set to indicate the presence of culvert head walls and similar hazards. In Connecticut, these posts are set whenever headwalls or inlet or outlet structures are within 15 feet of the outside edge of the traveled way; many states do not mark obstructions as far from the edge of the road as this, normally considering dangerous only those that are between the ditch and the edge of the traveled way.

Similar posts are also used to mark the edges of less dangerous or minor fills, in which case they are set about 20 feet apart. For culvert headwall markers, one post is normally set on each side of the obstruction. They should extend sufficiently high to warn snow removal equipment —generally 2½ to 3½ feet. Most such posts are painted white; for warning snow removal gangs, a black top may be added. Warning posts are usually of the same size as guard rail posts—8 ins. square or round posts 8 ins. in diameter.

Signs, Signals and Markers

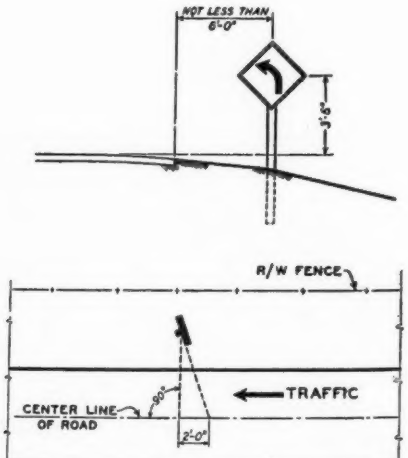
This section will, in general, discuss only the principles of the use of warning and directional signs, and the details of their maintenance.

Adequate warning signs are highly important in safeguarding and expediting traffic. The American Association of State Highway Officials have adopted certain standards in regard to size, shape, color and lettering, which should be observed. Some of these are shown in the illustration herewith.

Higher speeds of modern traffic require visibility at greater distances, and the increasing widths of roadways necessitate that signs be set farther from the center of the roadway. Therefore, adherence to standard signals, in which shape and color are factors, is highly desirable. Signs may be placed at approximately right angles to approaching traffic, but not exactly, in order to avoid a headlight reflection or glare that may prevent reading them; it is best to turn them slightly away from the road so that the reflection will be thrown back along the ditch line; or they may be set at an angle of about 45° with the centerline of the road.

As a rule, the sign should be about 3½ feet above the road surface, but on grades some change will be needed. In general, the sign should be placed so that the headlights will illuminate it at night. Generally the inside of curves is a poor location; also dips in the profile, humps in the grade or obstructions should be avoided. Ordinarily the sign may be placed about 5 feet from the edge of the pavement or traveled surface. Warning signs—except the STOP sign—should be located 350 feet, and even up to 450 feet, from the beginning of the danger zone, varying with the topography, probable speed of approach and similar factors.

A too frequent use of warning signs tends to create a disregard for them. Use them where they are needed, and nowhere

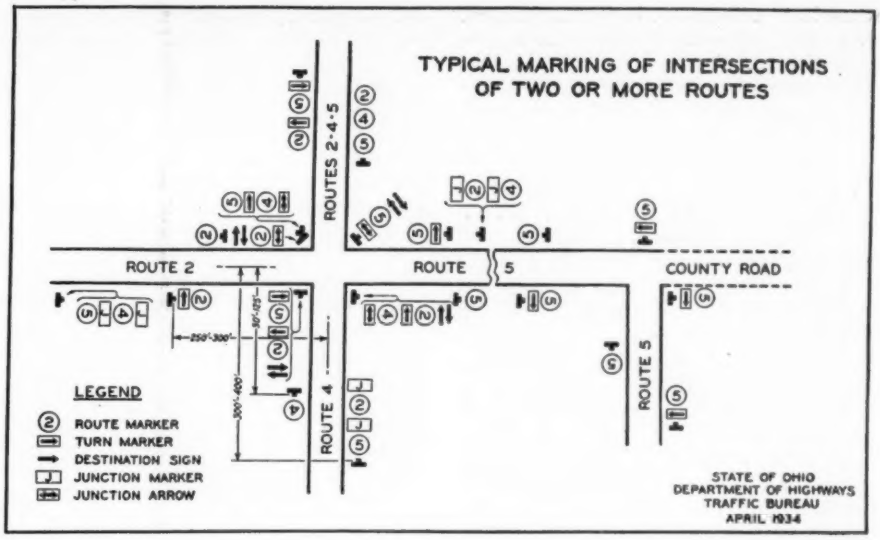


How Ohio places its signs.

else. Field observation and study — not office data—should be used to determine where they should be located.

The following directions and information regarding signs is from the Ohio Highway Department.[4]

Cross Road or Side Road signs should be restricted to intersections with roads that carry a fairly large volume of traffic, or where some unusual feature makes it advisable to call attention to the intersection. These signs should not be placed at unimproved intersecting roads. The use of STOP signs on the secondary roads is much more effective than Cross Road or Side Road signs on the main road.



Curve signs should be used only on those curves where safety requires a slackening of the speed normal for the approach to the curve, whether because of the high degree of curvature, lack of superelevation, obstructed visibility, narrow pavement, excessive crown or other reason. Reverse or S curve signs should be used where there are two curves in opposite directions, with less than 300 feet of straight road between, the need to be determined as for Curve signs. With a succession of curves, the Winding Road sign should be used, but if there is a particular hazard at one or more places, this should be marked in addition.

Turn signs should be used to indicate a turn that is a right angle or nearly so; Reverse Turn signs should be used to show two such turns so close to each other that two Turn signs are not desirable. The Hill sign should show a grade that should be descended more or less slowly; the Bad Hill or Steep Hill sign one where safety requires the use of second or low gear. The Slow sign should be used at hazardous points where it is absolutely necessary that speed be slackened. Narrow (either bridge or road) signs indicate those sections where the safe speed on the normal width of road cannot be maintained because of less clearances. Railroad signs should be used only at main lines, and not on spurs and minor sidings (some states require that all crossings be marked).

The standard STOP (often with "through traffic" added) sign should be used at points where traffic should come to a complete stop, or toward which a driver should advance with his car under complete control. The sign should ***not*** be used as an advance warning sign; nor, in cities, should it be used in connection with dead end street signs.

The most common use of the STOP sign will be on a secondary road at its intersection with an important road. It should be used at or very close to the point of danger. On secondary roads, it is usually placed at the right-of-way-line

of the intersected road. If for any reason, the STOP sign cannot be seen for a sufficient distance ahead, or if traffic would ordinarily not be slowed down sufficiently at the approach to the sign, an advance warning sign should be put up, as "Stop Sign Ahead."

As with other signs, judgment and good sense should be exercised. A STOP sign should be placed only where good judgment requires that traffic be brought to a complete stop. Use in other places may result in a disregard of the STOP sign at an important point.

Route Markers.—Markers to indicate route numbers should be so located as to be visible day and night. They should be placed on the right of the road, facing approaching traffic. Where both a warning sign and a route sign are to be placed, the warning sign should precede the route marker by a reasonable distance, as 100 feet. Markers should ordinarily be placed so that the center is about 3½ feet above ground; where more than one marker is erected on the same post, the bottom of the lower marker should not be less than 2 feet above the center of the roadway. In cities, where parked vehicles may interfere with vision, the lower sign should ordinarily be 7 feet from the top of the curb, unless parking is rigidly restricted; in residential areas, 6 ft. is enough. Positions near street lights are desirable.

In cities, markers will ordinarily be placed between the curb and walk, or on lamp standards or poles. In rural sections, marker posts should ordinarily be not less than 5 nor more than 7 feet from the edge of the traveled way. In cities, a marker should be erected at every street intersection; in rural sections, distance between markers should not generally exceed one mile, and should never be greater than 1½ miles, and there should be markers at all important intersections. At intersections, the marker should be placed from 50 to 125 feet beyond the intersection. At turns, a turn marker should be set 250 to 300 feet in advance of the turn, and another route marker 50 to 125 feet after the turn has been made.

In cities, special care should be taken that the turn markers are not set so far in advance of the corner to be turned that traffic will turn into an unimportant street or an alley in advance of the proper street.

In rural areas, route markers should not be set directly opposite each other, which tends to give the road a narrow appearance, but about 200 feet apart.

Sign Inspection.—Signs and markers are destroyed or damaged by accidents, storms, vandals and in other ways; they become rusty and illegible. The engineer or foreman in charge of signs will normally provide some periodic inspection service, but the regular maintenance workers also should note the condition of signs and markers. If the maintenance unit is equipped to make necessary repairs (except routine painting, etc.) these should be made. Otherwise a prompt report, with details of location, should be forwarded to the man in charge of that work.

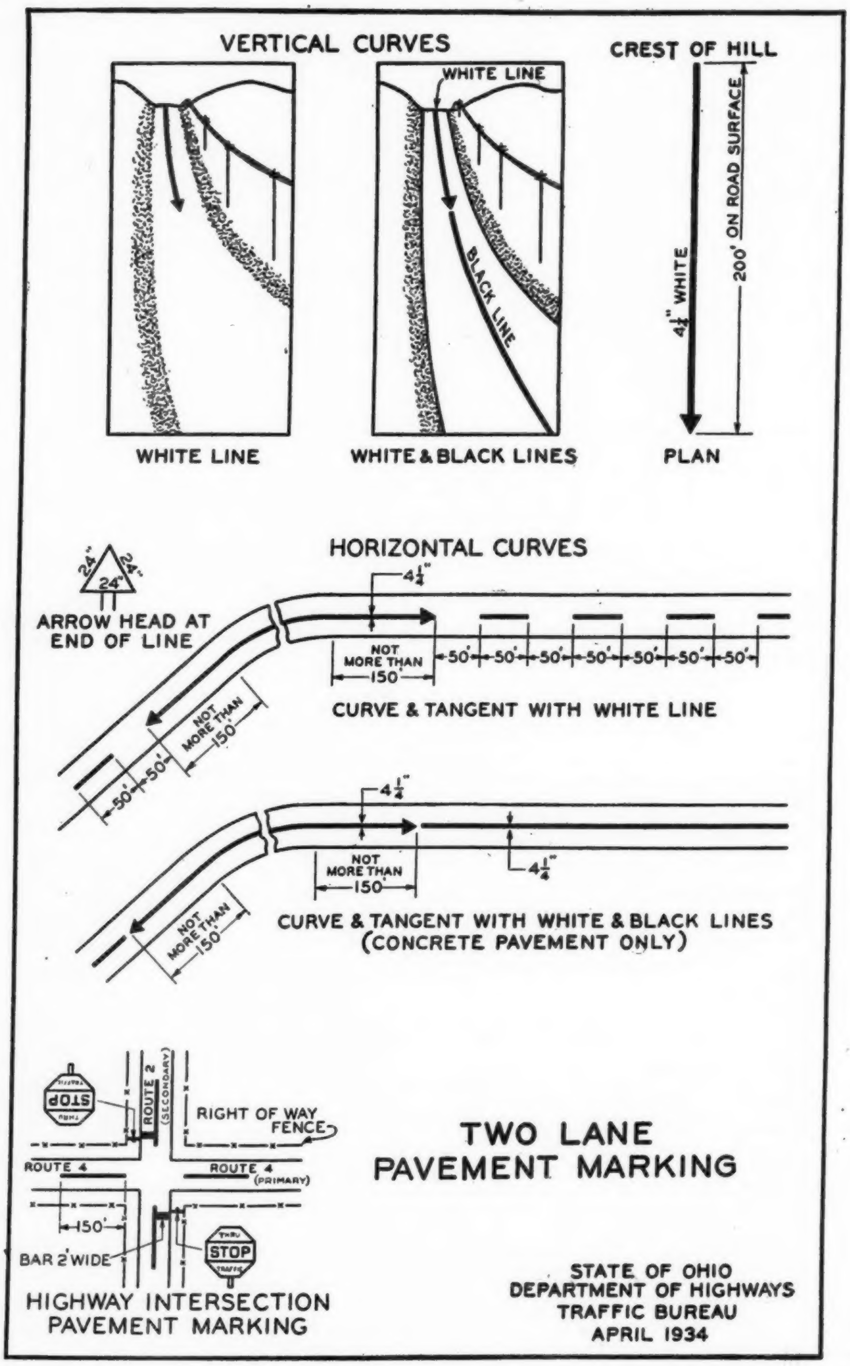
Sign Maintenance.—Periodic and regular inspections of all signs should be made. The inspector should have a record of all signs with him when making the inspection and should check each one to determine that it is not missing. The inspection should determine the need for repainting, repairing, or resetting sign posts and repainting or replacing signs; also whether the sign material is protected from weathering; whether standards are firm and signs securely fastened to them; and whether the signs are legible to drivers at the required distance. This should include a check-up on vegetation or other possible obstructions to vision.

The inspection should also determine the needs for additional signs. Changes often take place which require such additional signs, as a new farm road entrance, cattle crossings, etc.

Painting of signs (except repainting) is ordinarily done in the shop, and skilled painters should be employed.

Traffic and Centerlining

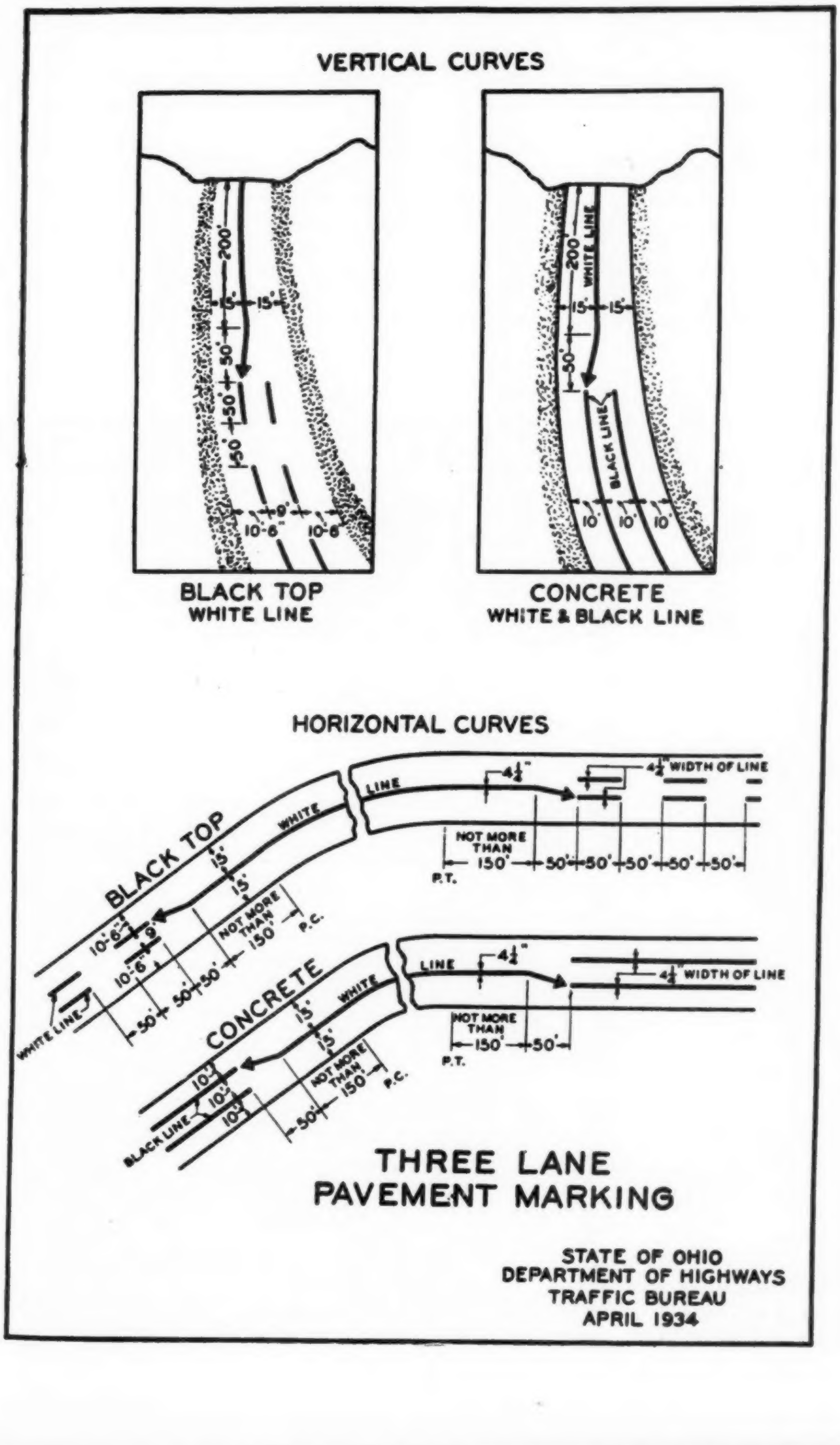
Pavement markings are valuable on curves or turns, approaches to the crest of a hill, at railroad crossings, on narrow pavements, on multiple lane pavements, approaches to intersections (especially those having signals), in areas subject to fogs, to warn of an obstruction, and for various other purposes. Pavement markings warn the driver without distracting his attention, tend to prevent collisions at horizontal and vertical curves, keep traffic in the proper area and generally do much to promote the orderly flow of traffic. Among their limitations are that they are worn away in a relatively short time, are obliterated by snow or ice, and are not always clearly visible in wet weather.



Black, white and yellow paints are most generally used, in either solid or broken lines. Practice in this regard varies among the states, and the engineer or foreman should learn and follow his own state standard. The same applies to width of line, which is generally 4 to 4½ ins. wide, but in some states is as narrow as 3 ins., especially on roads having little traffic, and in others as wide as 6 or even 8 ins.

At intersections with roads carrying a fairly heavy volume of traffic, the centerline should be carried back about 150 feet from the intersection of right of way lines. At railroad crossings, the first warning cross line should be about 300 feet from the nearest rail, and there should be one or preferably two other markings, the nearest one about 50 feet from the track. At obstacles, the line should begin 200 feet from the obstruction, and gradually angle so as to pass at least one foot to the right of it. On hills, the line should extend about 200 feet in each direction from the summit of the hill. On 3-lane roads, the lane markings should end about 50 feet before the centerline markings to the crest begin. On curves, the marking should begin about 150 feet from the beginning of actual curvature.

A great deal of care is necessary in order to lay out traffic lines accurately and paint them so that they are smooth and uniform. On concrete pavements having a center longitudinal joint, this is easy; and on concrete or other pavements with a sharply defined edge, the traffic line can be located by measuring from this edge. On pavements having an irregular or poorly defined edge, a light wire cable or a quarter or three-eighths inch rope may be laid along a proposed line and then adjusted back and forth by measurement and eye until a smooth curve or straight line is formed at the proper location. The pavement should then be marked at a 2-ft. interval with chalk or keel, or scratched, as a guide for the marker.



Paint used for traffic lines should be durable, dry quickly and hold its color. Ordinary paint should not be used. Special paints are manufactured by several firms. Application should be by machines, which may be either of the spray type or of the brush type. The former are required for rougher pavements and work well also on the smooth ones; the brush type will work only on the smooth types of surface. Five to fifteen gallons of paint, in a good machine, will mark about a mile of 4-inch line. Black paint, is stated by some engineers to have a much longer life than white paint. Lines that are slippery should be sanded.

The work of painting should be planned carefully to avoid heavier traffic. Ordinarily lines must be repainted about once a year, but this depends largely on the volume of traffic; when it is heavy, more frequent applications are needed; with light traffic the period between paintings may be even longer. However, the use of a set period of time between paints should be supplemented by inspections at such intervals that lines requiring paintings can be remarked in advance of heavy traffic periods.

There has been a small amount of marking of the edges of pavements. This is often a desirable thing to do, especially on the outside of curves, even when guard rails are in position; and when the center line does not follow the center line of the roadway, or where the edges of the pavement are irregular.

Detours

When a road is closed because of construction or for other reasons, a substitute route must be provided. These temporary routes or detours should be marked so plainly that the motorist who knows nothing of the country cannot get lost. Signs and markers should be located so that they cannot be missed. Properly marking detours and temporary routes requires good judgment.

At the points where the temporary route leaves the main route, a sign should be placed indicating that the road is closed. This sign should clearly indicate that the road is closed, or that it is open only for local traffic for a short distance. Otherwise, evidence that other traffic is using the road, and an incomplete barricade may tempt the traveler to try to get through. A red lantern should be mounted at night. In both cases, an arrow or other directional sign should clearly indicate which direction traffic should go. Also, 250 feet in advance of the barricade, a detour marker and arrow should be placed.

The temporary route should be marked with the same standard warning signs as the regular route, bearing in mind that the temporary route, because it is perhaps narrower, may need even more careful and complete markings. Turn signs should be placed in advance of every turn, and a confirming route marker placed within

100 feet after making the turn. A route marking sign should be placed just beyond every intersection. These should be carefully placed to be visible at night.

The detour is usually selected by others than the maintenance forces, but the latter will usually be required to maintain the temporary route. In the case of a detour from a state road carrying considerable traffic, protection fences should be placed; lanterns or torches may be needed for warning purposes at night; watchmen may have to be placed at bad railroad crossings.

With heavy traffic, dust becomes a most important hazard; therefore, oiling or other dust-laying may be a necessity. Graveling or other surfacing may have to be placed in advance of the opening of the detour.

Magnetic Sweepers

In some states a magnet is mounted on a motor truck, so that it just clears the road surface by 2 or 3 inches, and this unit makes regular trips over the highways to pick up nails and other pieces of metal that might puncture or damage tires. This procedure is worth while in these sections and at these times when there is much horse drawn traffic on the roads, as in the south during cotton ginning season. Nails, bolts and pieces of sharp metal are dropped by the wagons to form a hazard for motor car tires. Generally, such work is unnecessary on main roads in the east and north.

Snow and Ice Control

While classified under the heading of "Maintenance of Traffic Service," snow and ice control and removal, and the work incidental thereto, will not be discussed in this section. Considerable space was devoted to the subject in the October, November and December, 1937, issues of PUBLIC WORKS and in the August, September, October and November issues of 1938. Consideration is being given to a treatment of the subject following the completion of this text.

Drainage and Subdrainage

This subject is one of the most important for the men charged with the care and maintenance of highways and streets. Our most modern roads are, for the most part, fairly well designed for drainage; but the older roads, and also practically all of the secondary and minor roads lack adequate drainage. It is the duty of the maintenance forces to keep these roads in travelable shape, and without proper drainage, this cannot be done. H. H. Houk, former chief engineer of the Alabama Highway Department, speaking before the American Road Builders' Association said: "The maintenance budgets could have been enormously decreased without appreciable increase in construction costs had highway engineers realized the importance of soil stability."

The subject of drainage has to do with: 1. Removing water from the road surface. 2. The movement away from the road of this and other surface water by means of ditches, gutters, culverts, etc. 3. The control of ground water by means of subsurface or other drains.

The first portion of the problem has long been recognized; the second portion for almost as long; the third phase is one that has become recently recognized as a vital one if roadways are to be economically and satisfactorily maintained throughout the entire year.

Surface Drainage

The main objective of surface drainage, according to Lang, is to remove storm water quickly so that it will not interfere with the use of the road. To accomplish this purpose, roadbeds are crowned and elevated, and various structures are built to conduct the surface water to natural drainage courses.

Not only does water standing on the surface of the road tend to damage that surface, but it also interferes with, or makes traffic more hazardous. Water in side ditches may erode the channel and destroy portions of the road; or it may surcharge or choke a culvert or drain, and overflow and destroy a portion of the highway.

Therefore, the entire system must be designed to handle very heavy rainfalls without damage, and also to function properly even under winter conditions with ice and snow.

Road Crown.—The amount of crown or slope of the roadway toward the side ditches varies with the type of surface, the grade of the road and other factors. Nearly every street and highway department has its own standards which are generally based on a knowledge of local conditions. The crown must not be too great; a high-crowned road is difficult to drive on; drivers try to keep to the middle of the road; and it tends toward skidding in wet, icy or snowy weather.

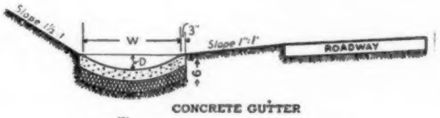
Side Ditches.—Side ditch design should provide for frequent cross-culverts to carry the water to the lower side of the road before any very large volume of water has been collected, in order to prevent possible overflowing of the road, erosion of the ditch or the shoulder, or other damage.

It is preferable to have a wide and shallow ditch, than a deep one, even though the hydraulic flow qualities of the shallow ditch are not nearly so good. This is a secondary factor in roadside ditches, which are not meant to be efficient structures for carrying large quantities of water. The shallow ditch lends itself much more readily to roadside improvement work, and it affords a greatly reduced hazard for automobiles which leave the road.

COBBLESTONE GUTTER

$D = \frac{W}{8}$ Cross-section is segment of a circle.

Use cobblestone 4" to 6". Sand bedding about 2" thick



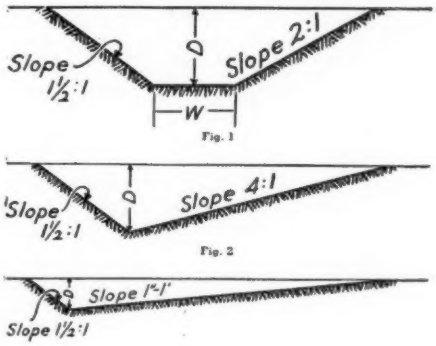
CONCRETE GUTTER

$D = \frac{W}{8}$ Cross-section is segment of a circle.

1:2:4 concrete about 6" thick.

Foundation of gravel, broken stone, or good quality earth.

SECTIONS OF EARTH DITCHES



These sections of ditches show common or good practices in construction. Types shown below can be cut with a grader. (Courtesy Gohi)

The topography or slope of the land will have an influence on the ditch depth. A slope of at least 6 inches in 100 feet should be provided. On level land, with culverts or cross drains 500 feet apart, the ditch would have to be 2½ feet deeper at the lower end than at the upper. There are, however, very few stretches of completely level land; if necessary, the ditches can slope to culverts at both ends from a central point, which would reduce the depth to one-half that required if all the slope were in one direction. A pipe may be installed in deep ditches, and covered over.

Cross drains, under ordinary conditions, will be needed about every 500 feet on slopes less than 3%, and about every 300 feet on slopes up to 7%. Local conditions may operate to change these figures, which represent average practice.

Velocity of Flow.—The capacity of a ditch and the velocity of flow in it for any depth of water can be computed, allowance being made for the roughness or smoothness of the ditch interior. However, these latter factors change as vegetation grows in the ditch, or is removed; or the ditch is eroded and changes its shape. Therefore, results of computations are only approximate. Observation of actual conditions at times of high water will give the best indication of the ability of the ditch to carry the required volume of water without erosion or damage.

In general, in earth ditches, a velocity of more than 2 feet per second is likely

to cause erosion. If grades and sections are such as to indicate a velocity greater than this, some protection or lining should be provided.

Velocities can be reduced by providing a wide and shallow ditch, but erosion often creates a channel in the bottom, into which the flow is concentrated, with resulting greater erosion.

Paving or Lining Ditches.—Where the grade of the ditch and the velocity of flow in it is such as to cause erosion, the ditch may be lined, or an enclosed conduit or pipe used. For lining, the invert may be paved with brick ("seconds" are often used) or with stone, grouted in place. Stone for this work should be 2 to 6 inches thick, 6 inches wide and preferably 8 inches in length. Brick or stone should be placed on a bedding course of gravel or similar material, and in laying should be tamped firmly in place. Cement grout or bituminous filling is desirable, though a sand filling is sometimes used. Bituminous filler should be high-viscosity with a quick set, preferably heated before application, and mopped in.

A lining may also be made of bituminous material. The simplest method is to place and tamp broken stone, and then spray with a heavy bituminous material, preferably the same as that mentioned above as suited for a filler for stone or brick lining. Or a cold mix may be used, or material similar to that used in adjacent repair or construction work. Such linings should be not less than 4 inches thick.

Light steel forms are especially desirable in order to obtain a true cross-section and grade. Board or plank forms can be used. Fairly good results, as regards shaping, can be obtained with carefully strung lines and a board template.

Paved or lined ditches, when used on earth, gravel or stabilized roads, must be so constructed and located that there is no interference with necessary use of a blade grader for maintenance.

Maintenance of Ditches.—All ditches should be kept clean and free from rubbish and debris. Periodical and regular inspection of gutters and drainage ditches is necessary, and this should be supplemented by observation even when engaged on other work. A clogged or blocked ditch should be repaired at once, lest a storm cause damage to the road. Conditions on adjacent lands that may interfere with proper ditch functioning or cause blocking or stoppage should be noted. Where the condition is a minor one, the maintenance foreman may properly discuss the matter with the property owner and cooperate in correcting the condition; where considerable work is involved, the situation should be taken up with the supervisor or engineer.

The use of a grader or maintainer is the most economical method of maintaining ditches, and it should generally be a policy to have ditches of such shape and construction that this equipment can be used. The only alternative is hand labor, which is costly. In general, for grader maintenance, the ditches should be broad and shallow, and the slope to them from the road quite flat. This arrangement is that generally desirable for safety and furtherance of roadside improvement.

Maintenance should keep the ditches in the shape and at the elevation for which they were designed and constructed.

The excess material resulting from cleaning and shaping with a grader or maintainer should be hauled away and used for necessary fills on washed-out shoulders and ditches, or otherwise disposed of. In using a blade, care should be taken not to destroy planting, sodding or seeding, and not to grade the ditch so deep as to undermine seeded or sodded slopes.

On some roads, deep ditches are provided to underdrain the road. It is desirable, as a safety factor, to install drain pipe and cover these.

Bank scouring should be prevented by keeping channels straight and protecting the banks with riprap or other materials.

Ed. Note: The remaining material on drainage and sub-drainage which was scheduled for this issue will be published in February, due to lack of space. The next regular installment will appear in the March issue.

Highway Maintenance in Australia

The drag or light grader is inadequate to cope with corrugations and the general surface maintenance of gravel roads subjected to fast motor traffic, and it has been found (in Victoria, according to a report by L. F. Loder, chief engineer) that power graders, preferably equipped with multiblade maintainers, provide the most economical method of carrying out this work. Where raised formations in open country have been used in construction, the power grader driver can, with casual assistance, carry out all necessary maintenance. Where table drains exist and particularly in timbered country, further assistance is required, and this is most economically given by a small truck patrol, which can handle quite a large area. This type of maintenance organization is that now generally used in undulating country, and many Councils have similarly reorganized their maintenance systems, or installed such a maintenance system where no systematic maintenance had previously been attempted, with the result that there is a rapidly-growing improvement in the maintenance of gravelled roads in many parts of the state.

On bituminous-surfaced roads truck patrols are now well established. In some cases these patrols also have a length of unsealed road to maintain, and during the past year the Board had fitted to a Ford V8 patrol truck a multiblade maintainer. The maintainer consists of a steel frame to which are bolted seven short cutting blades set at an angle, and a movable spreading blade at the rear of the cutting blades. This frame is attached to the truck between the cabin and the rear wheels, and can be raised or lowered by means of a system of levers operated from the driver's cabin.

The unit is intended for use on isolated sections of sand, gravel, or earth roads where there is not sufficient length to warrant the use of a power grader.

The spreading blade at the rear of the cutting blades is set to give a light coat of loose material, and care must be taken by the driver to see that the spreading blade is not allowed to bear on the road surface, due to wear of the cutting blades. At first, a man was used to operate the blades from the cabin, but experience has shown that the driver can manage it by himself after a little practice.

The attachment therefore avoids the necessity for a separate grader and operator, and spreads the loose material in an even coat instead of leaving a windrow in the center of the road. It is now proposed to equip another truck with a similar maintainer.

The time taken to change blades is half-hour for one man; the best operating speed is 8-9 miles per hour running in third gear.

A set of mild steel blades will last for 80 miles, the blades being ½ in. thick and 6 in. deep (4¾ in. available for cutting 1¼ in. required for bolting to frame). An average day's work is 63 miles of actual blading, which is equal to 31½ miles approximately 14 ft. wide. Petrol consumption in third gear while operating maintainer is seven miles per gallon.

Chemicals Used in Canadian Waterworks

Municipal waterworks in Canada during 1937 used 4,705 tons of alum, 624 tons of chlorine, 610 tons of lime, 800 tons of salt, 202 tons of soda ash, 100 tons of sulphur dioxide, 13 tons of chloride of lime, 24 tons of activated carbon, 37 tons of ammonium sulphate, and three tons of anhydrous ammonia.—*Canadian Municipal Review.*

Who Installs Service Pipes?

This was one of the items in a waterworks questionnaire sent out by PUBLIC WORKS. In reply, it was stated by 185 cities that this was done by the water department, with 12 of the cities noting the the water deparment's responsibility ended at the meter, and 20 noting that their responsibility ended at the curb line. In 90 cities, services are installed by the plumber. The type or kind of pipe used in the services is determined by the water works superintendent or city engineer in 175 cities, and by others in 95 cities. Normally, where the city engineer or waterworks superintendent does not determine the type of services, this is either fixed by ordinance or is decided by the city council or corresponding body.

Can a Too-Deep Well be Refilled?

One of our readers writes in for information on a subject on which we feel it is difficult to give long distance advice. We publish his letter below in the hope that other of our readers, with previous experience along this line, will give us the benefit of their knowledge:

"I have secured a lot of valuable information from PUBLIC WORKS, and make it a rule to read it carefully and file all clippings that I think will be of future use to me.

"I have a problem that I wonder if you or possibly some of your readers might give me information on. We drilled a 10" well. When we were down 400 feet we had a grand artesian well from which the water flowed in large quantity. We drilled the well on down to 1000 feet, and the well not only did not flow but we were unable to pump enough water from it to pay to pump it. If we fill the well up part way, would it be likely that we could start the well flowing again, and what material should we use?"

Gas Explosion at Dayton Sewage Plant

(Continued from page 18)

gas to the gas compressor house and storage tanks.

Damage to structures and equipment by the explosion has made it impossible to determine beyond question either how the gas escaped or how it became ignited, and the exact circumstances may never be known. Nevertheless, careful investigation revealed certain conditions which might have been responsible. Not only has a tenable source of escaping gas been found, but a possible means of ignition has also been discovered.

Source of Escaping Gas. All possible ways in which gas might have escaped into the gallery were investigated, including leaking joints, broken pipe and the like, with the conclusion that the gas most probably came from one or more of the numerous U-tube water seal slurry traps which had been placed just inside the gallery wall on each lateral gas pipe. The operators had found that the special water-seal flame traps which had been provided required frequent cleaning, due to fouling with material carried over with the gas from the gas domes, and they therefore changed the piping, which had been originally designed to have no openings of any kind within the gallery, by adding 30-in. U-tubes with open ends from which condensate and other excess liquor drained into the gallery gutter. It is known that one or more of these slurry traps have wholly or partially blown from time to time permitting gas to flow or bubble through into the gallery. One such instance had occurred within the previous three or four weeks, requiring the refilling of the water seal. It follows that the most probable source of escaping gas was the blowing of one or more of these seals after the night operator's last trip through the gallery, permitting gas to pour into the gallery through 2 in. pipe for the whole or some part of the 50 minutes which intervened between the operator's last visit and the explosion.

The possibility of blowing slurry trap seals was increased by the fact that the cast-iron gas domes, which had been designed to stand loosely in the gas vents so as to tilt in the event that gas pressures exceeded 21 in., had been grouted in by the operators because of the annoyance and inconvenience caused by the escape of foam and scum onto the surface of the sedimentation compartment by oozing up between the bottom edges of the gas domes and the concrete diaphrams on which they rested.

The hazard was also somewhat increased by the increase of the depth of relief seals near the gas domes (designed to blow off into the Imhoff tanks and thence to open air) from 18 in. to 21 in., leaving only a 9 in. differential between this seal and the 30 in. slurry trap seals in the gallery.

Source of Ignition. As in the search for the source of escaping gas, the destruction of evidence by the explosion prevents the conclusive discovery of the source of the spark or flame which ignited the gas. All possible sources were given careful consideration, and the burden of suspicion was found to lie upon one of two fractional horsepower motors which were running at the time in connection with a small experimental high-rate trickling filter model which had been installed near the easterly end of the gallery. The motor in question was brush operated, and although the condition of the commutator indicates that the brushes had not been sparking sufficiently to burn or score it, slight sparking is likely to occur in such motors at all times.

Lessons from Accident. Among the lessons to be learned from the Dayton accident are that every possible safeguard should be employed in the original design of both structures and equipment in all parts of a treatment plant involving hazards such as are present in a gas collecting system; and that under no circumstances should changes be made without the advice of the designer, or if this is impossible without a most careful review of the entire situation to gain assurance that, in correcting some operating inconvenience, a safeguard has not been destroyed or a hazard introduced.

Reducing Coagulant Demand at Watertown

(Continued from page 16)

the raw water: The table below will suggest how much to use.

To 1000 cc of raw water use	*Or to 1 Gal. of raw water use*	*To get this Dosage, use, in Grains per Gal.*	
		Volclay	*Alum*
1 cc of "A"	3.8 cc of "A"	0.8	0.4
1½ cc of "A"	5.7 cc of "A"	1.2	0.6
2 cc of "A"	7.6 cc of "A"	1.6	0.8
1½ cc of "B"	5.7 cc of "B"	1.4	0.4
2 cc of "B"	7.6 cc of "B"	1.9	0.5
3 cc of "B"	11.4 cc of "B"	2.8	0.7
1½ cc of "C"	5.7 cc of "C"	1.5	0.25
2 cc of "C"	7.6 cc of "C"	2.0	0.3
3 cc of "C"	11.4 cc of "C"	3.0	0.5
4 cc of "C"	15.2 cc of "C"	4.0	0.7
2 cc of "D"	7.6 cc of "D"	2.1	0.26
3 cc of "D"	11.4 cc of "D"	3.1	0.4
4 cc of "D"	15.2 cc of "D"	4.1	0.5

After running laboratory experiments with these combinations, checking the size of floc, the time of stir required to complete flocculation, the rate of settling and the turbidity of the sample both with and without sand plug filtration, it was decided that the optimum dosage was a combination of 0.25 g.p.g. of alum and 1.5 g.p.g. of volclay for treating water with a turbidity ranging between 80 and 90 ppm. (At the time of year that these

experiments were conducted, this was the average turbidity and all experimental work was conducted with turbidity ranging between these two figures.)

Using these dosages as a starting point for average water, a plant scale test was begun. In this method of treatment, combining the concentrated mixtures of alum and water and bentonite and water prior to treatment, it is essential that the bentonite be completely dispersed before the alum water is introduced. Immediately it was apparent that the flash mix under the dry feeder was not completely dispersing the bentonite, so the following method was adopted: The volclay was dropped from one of the two dry feeders into the flash mix and from there into a small barrel. This barrel was equipped with a simple stirrer that provided the additional agitation necessary for complete mixing. The volclay dispersion flows out of the barrel (from an opening placed above the bottom) into a trough leading to the plant mixing basin. The alum is dry fed from a second feeder into the flash mix and no further agitation is needed to complete the mixture. This alum water solution is then mixed with the bentonite water dispersion in the same trough, which leads to the mixing basins.

The complete cost of the additional equipment required was $25, which was offset in a few days by the saving in chemical cost. Chemical cost using the old method of treatment was $4,000 a year or approximately $11 a day, and it was estimated that the new treatment would cut this figure to $1,800 a year or about $5 a day.

The results were excellent. Water as it passed over to the filters had a turbidity of about 10 ppm. and the effluent turbidity was less than 1 ppm. It has been the policy of the operators of this plant to wash the filter beds once every 24 hours regardless of the condition of these beds, so an accurate check on the filter runs was not available, but examination of the two waters using the two treatments, as they passed on to the filters, showed that the new treatment was taking a large load off the sand beds.

Analysis of the raw water as compared to the water after bentonite treatment can be seen in the following table:

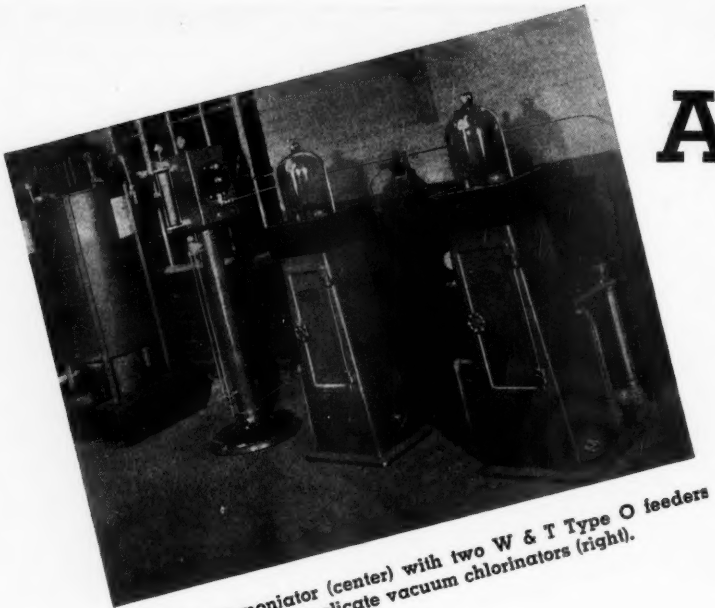
	Raw Water, ppm.	*Filtered Water, ppm*
Turbidity, ppm	87	1
Total alkalinity, as ppm $CaCO_3$	197	190
Carbonate alkalinity as $CaCO_3$	0	0
Bicarbonate alkalinity	197	190
Free Carbon Dioxide	16	5
Total Hardness	252	252
Carbonate Hardness	197	190
Non-carbonate Hardness	55	62
Magnesium	115	...

There was some concern on the part of the operators as to the condition the mixing and sedimentation basins would be in when cleaning time came around, but it was found that the sludge resulting from the new treatment was easier to clean up and that it wasn't piling up in a slope along the baffles of the maxing basins. The filter bed sand was carefully watched and, contrary to earlier assumptions, the beds were cleaned with the same efficiency as previously.

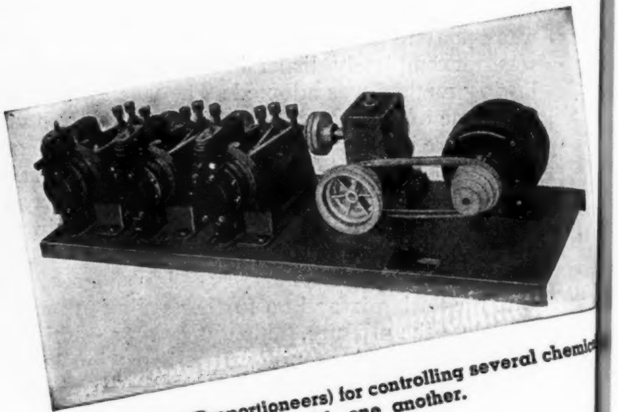
The ease and cleanliness of handling volclay, the saving in cost of chemical treatment that it presents, and the efficient results of its use as a coagulant have prompted the Watertown plant officials to adopt it for regular use in the treatment of the Lake Kampeska water.

Full credit is here extended to Mr. Schultz, to Ralph Reed, city engineer, and Walter Hester of Watertown, S. D. Without the whole-hearted assistance and cooperation of these men, this article might never have been written.

A Glossary of C



W & T ammoniator (center) with two W & T Type O feeders (left) and duplicate vacuum chlorinators (right).



Triplex Midget (Proportioneers) for controlling several chemic in step with one another.

(Operation, Uses and Limitations of the Various Types of Equipment. 1—Direct Feed)

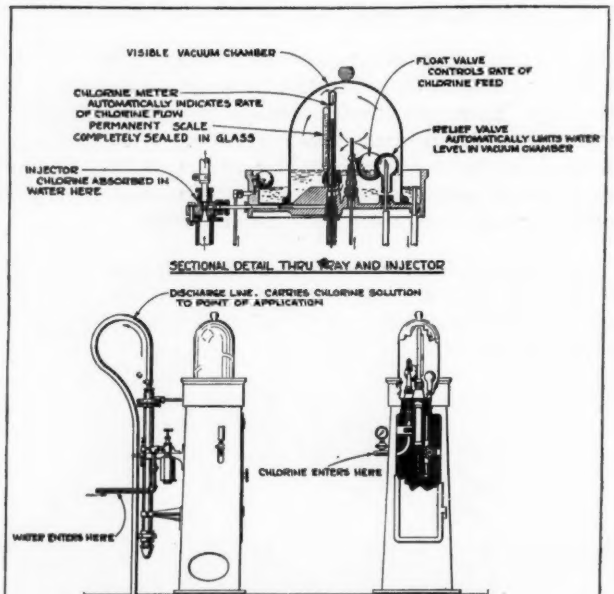
Operation—Pressure in the chlorine cylinder actuates this type, forcing the gas through the control mechanism and into the body of water or sewage being treated through a diffusor which breaks up the gas into small bubbles.

Uses—Used where water under sufficient pressure is not available, or where a low investment in equipment is necessary.

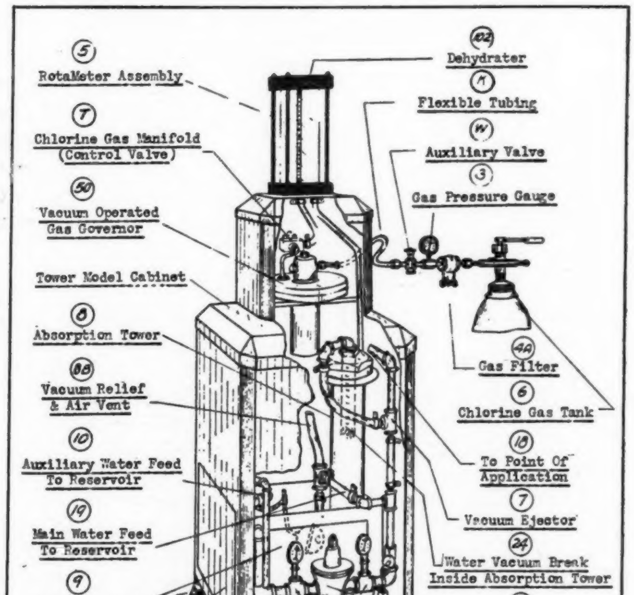
Limitations—Minimum rate of feed, *0.05* lb. per day. Maximum rate of feed recommended, *25* lbs. per day, but under suitable conditions can be much higher.

Maximum pressure at point of application, not over 25 lbs. and preferably less. Point of application must be chosen with great care to prevent corrosion of metal pipes or, if in an open body, to prevent escape of chlorine bubbles from the surface. As gas from machine to point of application is conveyed in a small silver tube, the practicable distance is limited.

Available as manual control, semi-automatic, and as proportional automatic control. Proportional control obtained by differential head produced by venturi tube or flume, pitot tube, orifice plate, etc.



Wallace & Tiernan manual control chlorinator, solution feed.



Everson vacuum operated chlorine Sterelator.

Chlorination Terms

By ELLIS K. PHELPS

In this second installment of the glossary, the author describes the various equipment used in the chlorination of water supplies and the functions of each.

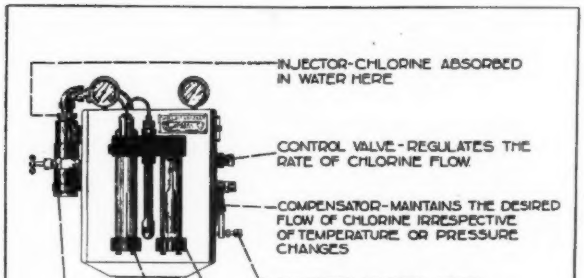


Diagram showing method of operation of W & T Type MSP-M Chlorinator

2—Solution Feed. (Semi-Vacuum Control)

Operation—Pressure in the chlorine cylinder actuates the control mechanism under a positive pressure. The controlled gas flow is delivered to a chamber maintained under a negative pressure by a small water injector. The gas passes to the throat of this injector and is dissolved in water, making a chlorine-water solution. This solution is conveyed to the point of application through a chlorine-resistant rubber hose.

Uses—Used where water under sufficient pressure (at least 25 lbs. per sq. in.) is available and capacities of chlorine feed are 100 lbs. per day or less. Usually in small water works or small sewage plants. Capacities up to 500 lbs. per day can be had under suitable conditions. Can be used to inject chlorine into pressure mains, where water to operate injector is available under pressure of at least three times the pressure at the point of application.

Limitations—Available as manual control or as semi-automatic. Not available as proportional automatic.

3—Solution Feed. (Vacuum Control)

Operation—Chlorine gas under pressure is delivered to the vacuum chlorinator, and enters through an inlet valve, so designed that it is closed at all times except when there is a sufficient negative head or partial vacuum in the chlorinator. The negative head is produced by an injector operated by the water used to form the chlorine-water solution. If for any reason this negative head is destroyed, the inlet valve will shut off the chlorine, thus making this the safest of all types of chlorinators. Because gas is handled under negative pressures, materials such as hard rubber and glass can be used more extensively than where pressures are encountered, and leaks in the apparatus are of course entirely eliminated. This results in the extremely low maintenance costs of this style of control unit.

Uses—Can be used anywhere if water under sufficient pressure (at least 25 lbs. per sq. in.) is available. If pressure exists at the point of application, the operating water pressure for the chlorinator must be at least three times greater. This type is the most versatile of chlorinators.

Limitations—Capacities available from 0.05 lb. per day to 6,000 lbs. per day in single units. Manual control, semi-automatic, or proportional automatic control. Can be controlled hydraulically or by electrical relays from remote points. Range of feeds are from 7-1 in individual units, but when operated in series, much wider ranges are common. They can be installed so as to chlorinate water in a pipe or channel when flowing in one direction and shut off on reverse flows; or to treat water flowing in either direction, proportionately.

(There seems to be no limit to what can be done with these units.)

4—Ammoniators

Operation—Usually direct feed and manual control, although solution feed ammoniators using anhydrous ammonia and proportional feed ammoniators are available. These units function on the same principles of operation as chlorinators, being actuated by the vapor pressure in the ammonia cylinder. Ammonia gas or solution is handled in ordinary iron or steel pipe but readily attacks brass or copper, and therefore cannot be fed through a chlorinator.

Uses—Ammoniators feeding aqua ammonia or solutions of ammonium sulphate are widely used and are cheaper than ammoniators feeding anhydrous ammonia. Available for manual, semi-automatic or proportional control.

Limitations — Ammonia precipitates lime from waters containing calcium and is apt to cause trouble in solution-feed mechanisms, particularly where hard water is used. It is for this reason that, where anhydrous ammonia is used, it is usually applied as a gas directly to the water being treated, which supplies tremendous dilution.

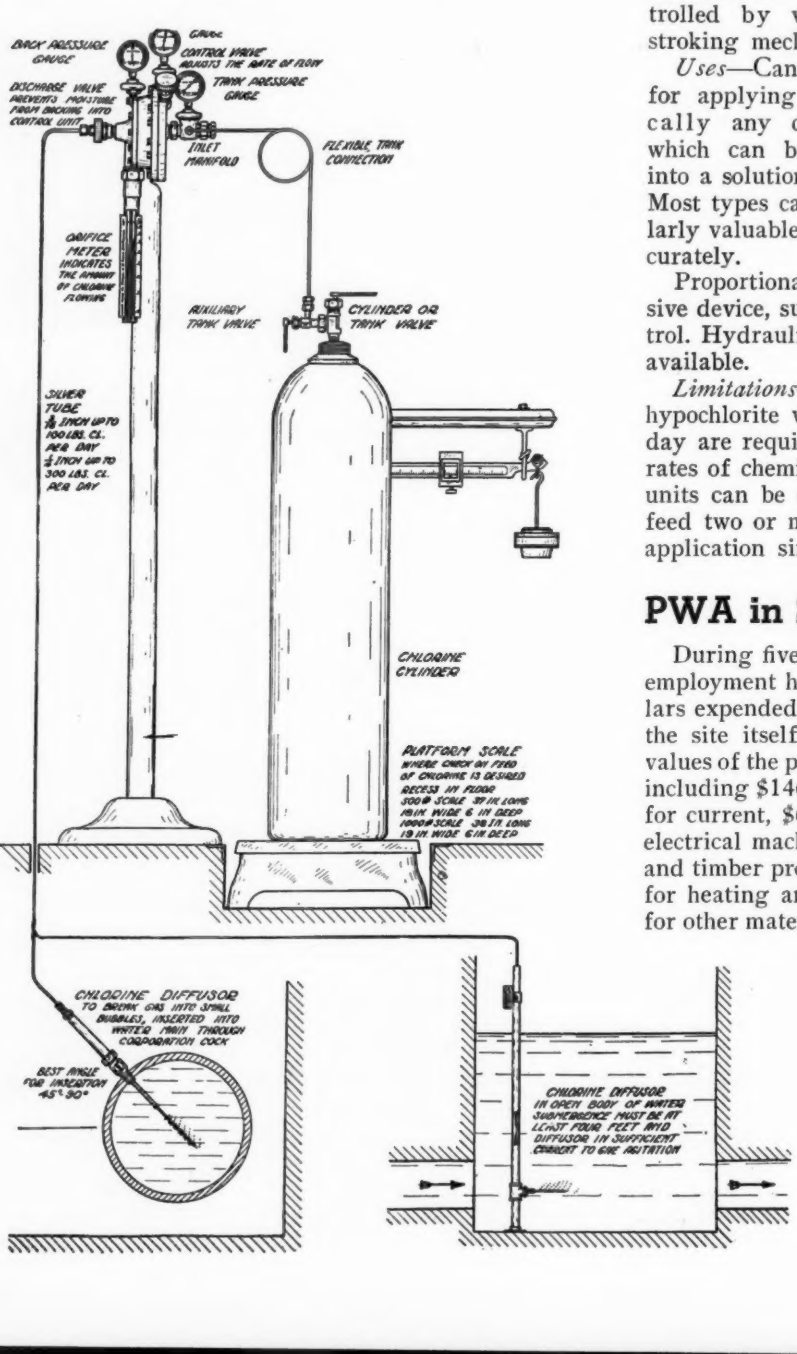


Diagram of Pardee chlorine control unit, mounted on floor stand.

5—Hypo-chlorinators

Operation —There are many types of hypo-chlorinators and methods of operating them. Most of the older types depended on constant-head boxes with small orifices. Very few of these have ever been successful. Most of the hypo-chlorinators used today feed the hypochlorite solution by means of a small rubber diaphragm pump, the discharge of which can be controlled by various stroking mechanisms.

The Everson Rota Meter.

Uses—Can be used for applying practically any chemical which can be made into a solution, and some will handle lime slurry, etc. Most types can inject against high pressure. Particularly valuable where small quantities are to be fed accurately.

Proportionate feed types require some flow-responsive device, such as a water meter, to operate as a control. Hydraulic, electric and gasoline motor drives are available.

Limitations—They are not economical for feeding hypochlorite where more than two or three pounds a day are required. By diluting the solutions, very low rates of chemical application can be obtained. Several units can be operated from a single prime mover to feed two or more chemicals to one or more points of application simultaneously.

PWA in Sewage Disposal Projects

During five years of PWA, 1,025,000 man-hours of employment have been furnished for each million dollars expended on sewage disposal projects, 358,000 on the site itself and 667,000 in regular industry; the values of the products used per million dollars expended including $146,000 for iron and steel products, $87,300 for current, $62,500 for sand and gravel, $34,000 for electrical machinery and supplies, $18,500 for lumber and timber products, $10,500 for brick and tile, $2,600 for heating and ventilating equipment, and $147,600 for other materials; a total of $509,000.

Comment and Experience

Readers are invited to submit problems, comments, reports of experiments or experiences in research, operation or construction.

Thawing Copper Pipe

December 24, 1938

Editor, Public Works,

Dear Sir:

In your December issue I note an article by J. E. Germann on thawing frozen water mains and services by electricity. Mr. Germann, in the first paragraph of the article, says that he has thawed out all kinds of mains and services, including copper service pipes.

If he has had any experience in thawing copper pipes, he could give us some valuable information. We have been trying to get a suitable apparatus for thawing copper pipes and last winter one of the welding companies furnished us a welding generator driven by a gas engine on trial with the understanding that if it did not thaw copper pipe, we would not buy it.

Accordingly we took 60 ft. of 1" type K standard copper service pipe and filled it with water and allowed it to freeze. Pressure was applied to one end of the pipe, the other end being open, and 400 amps. continuously fed through the full length of the pipe for three hours without any effect that could be noted, the pipe not even being warm enough at the end of three hours to melt snowflakes which fell on it.

The gentleman, while he mentions that he has had a lot of experience with copper pipe, does not mention that experience in his article. Copper pipe thawing is one of the problems of modern water works practice, as most cities require copper pipe by ordinance for new services or replacements, this being the case in our city.

The best information I can get is that it takes 800 or 900 amps. to thaw out 1" type K copper pipe in any reasonable length of time.

We have tried different generators but have never found a satisfactory substitute for transformers in pipe thawing.

Any information you can, or feel that you would like to, give us on the subject would be very much appreciated and I think would be of benefit to others having similar problems.

Yours very truly,

M. C. Bright, Supt.

Water and Light Department, Virginia, Minn.

The Merit System in the Dallas Water Department

For six years all Dallas water employes, except the superintendent, have been under civil service, being selected and promoted on the basis of merit. Applicants for positions must pass examinations of the civil service board with grades of 70 or better. Whenever an opening occurs, selection of a man for it is made from three names submitted by the civil service board. Each new employe is put on 90 days probation and if his work is satisfactory, his employment is made permanent.

In making promotions, all employes in the next lower classification are permitted to take a "promotional examination" for the position. Employes may be eligible under more than one classification, if they desire.

Every 90 days department heads of Dallas must submit to the civil service board the efficiency ratings of all employes. Additional compensation up to 1¾ per cent is given to employes with above-average ratings. Sometimes, if the service is of such a nature as to warrant special recognition, the board may grant special credits; a chemist was given an additional credit of 7 per cent for working out a water purification method that saves the city about $4,000 annually. Employes passing the state examination for licensed water works operators earn an extra ½ per cent.

Employes whose efficiency rating falls below 70 per cent are subject to dismissal after a hearing. An employe also can be dismissed for other causes, but only after a hearing before the civil service board, which is composed of three citizens.

Danish Experiences With Three-Axle Rollers

Increasing importance attaches to accurate surface finish in bituminous road construction. Both tandem and three-wheeled rollers of the ordinary two-axled type have reached the limit of their useful development, according to S. Presser, in Teer und Bitumen. A disadvantage of both types consists in the pushing action of the front wheel, which is often very heavy and displaces a disproportionate amount of material in the direction of rolling, whilst the compressive action is relatively small. There is thus a tendency to produce corrugations which the rear roller does not entirely eliminate, and which can be corrected only by subsequent transverse or diagonal rolling. The author advocates the use of a full-sized central roll. Machines of this type are in use in Denmark. Viagraph records taken under the auspices of the Danish Road Laboratory *(Dansk Vejlaboratorium)* illustrate the superior smoothness and freedom from corrugations of surfacings, in use for one and five years respectively, on which the three-axled rollers have been used. The machines are easily turned, even at sharp angles, and this facilitates rolling at road junctions.—*Road Abstracts.*

Keeping Frogs, Newts, etc. Out of Reservoirs

Editor of *Public Works*

Dear Sir:

Perhaps you already know that the Secretary of the Ohio Conference on Water Purification recommended your April number* to the members of the Conference. Accordingly, the Conference ordered a number of copies for distribution at its annual meeting and the writer has received a copy.

After reading it, it is easy to see the reason for his recommendation because the subject of water treatment has been covered in masterly fashion. There is, however, one little point where I think the text could be improved.

On page 29, second paragraph, your text reads: "When fenced, the bottom 2 feet of the fence should be of close mesh to prevent the entrance of frogs, newts or salamanders which may thus enter the distribution system and cause complaints from customers."

My observation is that when frogs, newts and salamanders are yearning for water they become pretty good climbers, so my rendition of that sentence would be about like this: "When fenced, the bottom 15 inches to 2 feet should be of sheet iron or similar smooth material to prevent the entrance of frogs," etc. . . . It will also be an advantage to have the top of this material slightly overhanging the bottom. In other words, slope it slightly outward at the top.

Yours very truly

Glenn Green, Chemist in Charge,

Cambridge Water Works, Cambridge, O.

*This contained the 25-page article "The Operation of Water Treatment Plants."

The Waterworks Digest

Abstracts of the main features of all important articles dealing with waterworks and water purification that appeared in the previous month's periodicals.

Ground Water Depletion in London

London, England, draws 11.5% of its water supply (20 mgd) from wells. During a long period there has been a gradual lowering of the ground water level—300 ft. in 60 years in West London. Average falls recorded during the past 30 yrs. vary from 0.5 to 5 ft. per year. It is believed that within 35 yrs. a negligible amount of water will be available, and the water will be contaminated with salt tidal water before that. There is also danger of polluted water from superficial gravels entering through abandoned wells.[D3]

Silicate of Soda as Coagulation Aid

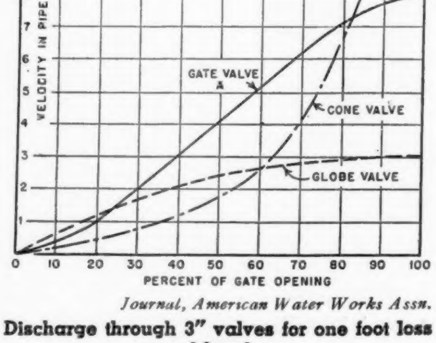
At Wheeling, W. Va., the Ohio river turbidity is about 9 ppm generally, but after floods drops to almost zero; the iron content also drops from 4 ppm to almost zero. For about 3 days after floods colloidal turbidity is difficult to remove, even though the dose of copperas be increased from the normal 0.2 gr. per gal. to 3 gr. By adding 0.2 gr. of silica as silicate of soda to 0.2 gr. of copperas the result was better than with 3 gr. of copperas alone, water reaching the filters with a turbidity of less than 1 ppm. Diluted silicate of soda is fed through the same feed line as the ferrous sulphate solution.[G1]

Repairing Reservoir Leaks

A bowl-shaped reservoir was built in Corpus Christi, 10 mg capacity, lined with concrete slabs, the upper 15.5 of water depth being clay-sand embankment with a face slope of 45°; these upper slabs carrying short columns which support a groined roof. Grooves 3″ deep were left in the joints between slabs to permit calking same, calking to be done after reservoir had been filled and slabs settled to final bearing. When filled to 10 ft. below the top, the reservoir leaked 660,000 gpd. It was used below this level for about 6 mos., during which time leakage decreased 60%; then emptied and the joints calked with cement and oakum. On filling, the leakage was 525,000 gpd, apparently caused by flexure of slabs on the elastic soil due to warping at the columns. Then the cement-oakum jointing was removed and replaced with hot coal tar and oakum, and hot coal tar pitch swabbed 18 to 24″ wide along the joint, covered with waterproofing fabric 9″ wide, a second swabbing of pitch, a layer of fabric 12″ wide and a third swabbing. The whole area was then treated with three applications of neat cement grout, and finally three tons of bentonite sprinkled over the entire area. When again filled, up to 11.6 below full level there was no leakage; when filled, 7,400 gpd leakage, including evaporation.[E3]

Pressure Caused by Closing Valves

Tests made at the hydraulic laboratory of the University of Toronto show different characteristics of gate, globe and cone valves when being opened and closed. The cone valve, when closed 20% from fully open, reduces the discharge 73%; the gate valve, 11%; closing the globe valve 50% reduces the discharge 19%; these being on a short pipe line. On a line of 2000 ft. of 10″ pipe, a gate valve 80% closed reduced pipe velocity only 16%. A globe valve 80% closed reduced pipe velocity 23%. Closing a cone valve 50% reduced velocity 17%, and closing 80% reduced velocity about 65%. Since the velocity in closing from 80% to 100% must be reduced 84% by the gate valve, 77% by a globe valve, and only 35% by a cone valve, the last produces much smaller pressure rise in a main when closed at a uniform rate than do the others.[A13]



Journal, American Water Works Assn.

Discharge through 3″ valves for one foot loss of head.

Diffusing Water Underground

Depletion of underground water supply of the west end of Long Island, N. Y., is partly remedied by returning to the water bearing strata used water that is suitable. On Jan. 1, 1938, there were 106 recorded installations diffusing 29 mgd, of which 95 return water used for air conditioning; the other 11, condensing water from manufacturing plants. The kind of well used for diffusing is important. On Long Island the standard comprises a pit of large diameter, and below this a pipe surrounded with gravel, preferably a 12″ pipe. In some cases pump pressure is used to force water into this pipe, and 2,000 to 3,000 gpm is forced into coarse gravel; suggesting utilizing storm run-off or other surplus water in this way.[A1]

Mains and Joints of Different Types

Cast iron, steel and reinforced concrete mains are used in Washington, D. C. Each has its advantages and disadvantages, but any one could be designed to hold any designed pressure and last indefinitely, and choice can be made on annual cost. In the matter of maintenance of carrying capacity, reinforced concrete pipe seems to have the advantage; the useful life of thin cement mortar and bituminous enamel linings for ferrous pipes is unpredictable but present performance indicates they should hold up well, and large mains can be relined at reasonable cost. Lead joints have indisputable long life and give flexibility but are unreliable under vibration. Sulphur base joints, though apparently inflexible, give remarkable performance under vibration and settlement owing to healing of leaks. They have been in use for 40 yrs. —how much longer life they will have is unknown. Rubber-packed mechanical joints give a remarkably tight line. The

life of the rubber is unpredictable, but keeping it moist and excluding light is one of the best methods for preserving rubber. Since 1933 most Washington mains over 20" diameter have been laid with this type joint and not a joint has failed. Failures of lead joints are due almost entirely to improper yarning, a honeycomb pour or making two pours. Sulphur base compound failures are due to moisture, grease or dirt in the joint, burning the material or pouring it at improper temperature. Leaking mechanical joints are rare and are caused by slack bolts, tightening unevenly around the pipe, or too much deflection in the pipe line.[A4]

Removing Manganese Deposits from Filters

Gravel in the rapid sand filters of the Pennsylvania Water Co. have always received manganese deposits, which so increased in 1933-34 as to cement the gravel, and prevent proper filter washing. Caustic soda cleaned shallow filters, but was not successful with deep ones. In 1936 a high lime treatment was tried, and repeated at intervals. It was concluded that a 1% caustic soda solution is effective in removing manganese, alumina and iron coatings from gravel. High lime treatment built up deposits on the sand; the manner in which the deposits formed depending on the effective size of the sand. The same treatment was tried on an anthrafilt filter also, and in 8 mos. the sand, with 0.55 mm effective size, took on 16 lb. of deposit per cu. ft., and the 0.70 mm anthrafilt took on 7.75 lb. Giving both filters low pH treatment removed 76.5% of the deposit from the sand and 99% from the anthrafilt. Manganese dioxide coating on the sand grains helped prevent similar deposits on the gravel.[A10]

Bibliography of Waterworks Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

A *Journal, American Water Works Ass'n*
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1. Diffusing Pits for Recharging Water into Underground Formations. By J. H. Sanford. Pp. 1755-1766.
2. Electrolysis. By G. Cunningham. Pp. 1767-1772.
3. Should Plumbing Installation Be Approved by the Water Department? By E. F. Dugger. Pp. 1775-1779.
4. Experiences with Cast-Iron, Steel and Reinforced Concrete Water Mains. By H. Beckett. Pp. 1780-1786.
5. Leakage from Distribution System. By A. M. Field. Pp. 1787-1790.
6. *c.* Laying the 30-Inch Subaqueous Main Under Curtis Creek, Baltimore. By J. M. Kinnear. Pp 1791-1801.
7. *t.* Practical Application of the Langelier Method. By C. P. Hoover. Pp. 1802-1807.
8. *t.* New Plating Medium for Coliform Analysis: Citrate Ricinoleate Agar. By M. L. Littman and C. N. Stark, Pp. 1808-1827.
9. *t.* Properties and Determination of Methane in Ground Waters. By T. E. Larson. Pp. 1828-1835.
10. Manganese and Iron Deposits on Sand and Anthrafilt Filters. By R. B. Adams. Pp. 1836-1846.
11. Private Fire Lines in New York State. By W. T. Miller. Pp. 1847-1854.
12. What Is Adequate Hydrant Distribution. By G. W. Booth. Pp. 1855-1857.
13. Action of Valves in Pipes. By R. W. Angus. Pp. 1858-1871.
14. The Water Supply of Greater Winnipeg. By W. M. Scott. Pp. 1872-1885.

D *The Surveyor*
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1. Design of Large Automatic Pumping Stations. By L. B. Escritt. Pp. 595-597.
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2. *p.* Construction of an Impounding Reservoir (Rochdale, England). By W. Atkinson. Pp. 677-679.
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3. *p.* Underground Water Supply of the County of London. By S. Buchan. Pp. 699-700.
4. *p.* Construction of an Impounding Reservoir (Rochdale). By W. Atkinson. Pp. 701-702.
5. Earthing to Water Mains (Corrosion). Pp. 709-710.

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3. Corpus Christi Builds a Covered Reservoir. By C. T. Bartlett. Pp. 727-731.
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4. Wells on the Public Range. By G. C. Waring. Pp. 757-758.
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Wallace & Tiernan Celebrate 25th Anniversary

Climaxing twenty-five years progress in the field of chlorination, Wallace & Tiernan Co., Inc., celebrated the 25th anniversary of its incorporation—November 13, 1913—with a series of Silver Jubilee celebrations.

Selecting Friday, November 11th, as the nearest working day to the actual anniversary date—Sunday, November 13th—open house for all employees and their husbands and wives was held at the headquarters and factory at Belleville, N. J., with an extensive program by various intercompany employee activities.

Beginning the formal part of the ceremonies at 11 o'clock, two minutes of silence commemorating Armistice Day, was followed by sounding of Taps and a group of appropriate choral numbers by the W. & T. Glee Club, after which M. F. Tiernan, president of the company, reviewed various high lights in the growth of the organization from the date of its incorporation when he and Mr. Wallace joined together in a business enterprise, without capital and without definite plans of procedure,—and traced the growth of the organization through its twenty-five years of existence to today with its thousand or more employees,—with its extensive headquarters office and factory buildings occupying over six acres at Belleville, N. J., and with additional factories in Canada and England and with forty-two sales and service headquarters, together with representatives in over fifty-seven foreign countries. William J. Orchard, general sales manager, emphasized in his talk the growth of the personnel of the organization and the fact that today more than six thousand people owe their economic existence to the activities of the organization and the fact that every product or process marketed by the company is a direct benefit to the welfare of mankind touching on the preservation of health or life itself.

The formal program included the presentation by Joseph Mancuso, the first W. & T. employee, of a group of portraits of the two founders, Mr. Wallace and Mr. Tiernan, painted by Sidney E. Dickinson, N. A., and Ivan G. Olinsky, N.A., and secured by personal subscription of the employees. A rather unique feature of this gift was the fact that two artists were engaged to paint two portraits each of the founders,—artists with totally different techniques who approached their subjects in an entirely different manner.

A buffet luncheon was served to 1200, after which there were entertainment features. On the following Tuesday evening, Mr. Wallace and Mr. Tiernan gave a banquet at which 250 were present.

The Sewerage Digest

A Digest of the Sewerage Literature of the Month giving the main features of all the important articles published

Stainless Steel for Sewage Plants

Studies by the Sanitary District of Chicago have led them to adopt 18-8 stainless steel (18% chrome—8% nickel) for parts of plant where abrasion and corrosion are severe. These include floats of control structures on intercepting sewers; surge bins, unloaders, conveyors, spouts and gates for handling sludge in the drying plant; also sludge mixers, the paddle tips of the mixers, however, being of chromium-tungsten-cobalt steel alloy. Solid stainless steel is used to resist combined corrosion and abrasion, stainless clad steel where corrosion is the main destructive agent. In heaters that raise gases and vapors to 1000° F, and the drying towers, stainless steel is used. More extensive use of alloy steels will be made in the Southwest Side Treatment Works.[H4]

Grease Removal by Aero-Chlorination

At Lancaster, Pa., South Plant (activated sludge) return sludge averaged 21.63% (dry basis) grease, which interfered with good operation. Extensive plant scale tests were made with aeration alone, chlorine alone, and aero-chlorination; air being applied at the rate of 0.14 cu. ft. per gal. and using 2 ppm chlorine (based on sewage flow). Aeration alone increased grease removal 187% over treatment without aeration or chlorine, aero-chlorination 781%, and chlorination alone 219%. Aero-chlorination reduced the grease content of the raw sewage 80% and was adopted. Since then the plant has experienced its first 6 months of continuously successful operation of the activated sludge phase of treatment.[G1]

Intermittent Sand Filtration

At Hyannis, Mass., a Cape Cod summer resort of about 2,000 population, septic tank effluent is filtered through intermittent sand filters, using the natural sand as found, after removing a few inches of top soil. The calculated loading is 600 persons per acre in winter and 800 in summer. In each bed 150 ft. square are laid 3 lines of drains 3 ft. deep; but owing to the porous soil, no water has appeared at their outlets. The dosing tank is of 40,000 gal. capacity.[E3]

Ley Creek Sewage Works

This plant serves several small communities adjacent to Syracuse, replacing six small plants. Design capacity, 4.5 mgd from 30,000 pop. Pumps and primary tanks accommodate 10 mgd. Located on small creek ¾ mile from Lake Onondaga because at the lake there is no suitable foundation for a depth of over 200 ft. Plant lies between two creeks at their junction, on 8 ft. of blue clay underlain with quicksand; when blue clay is pierced, ground water rises to within a foot of the surface, 8 ft. above the water in the creeks. A dewatering caisson was sunk 40 ft. deep and pumped at 2,000 gpm for nearly two years during construction.

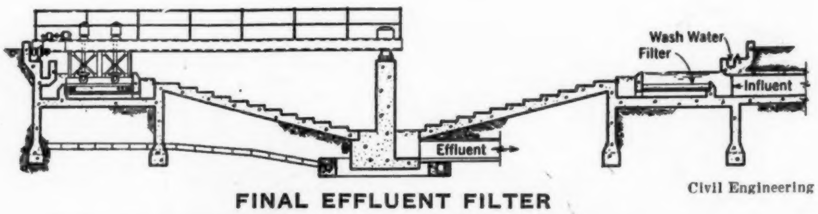
Activated sludge treatment was used because of low flow in creek receiving effluent. Screenings from mechanically cleaned screen are pulverized and returned to the sewage. A preaeration tank, 15 min. detention is intended primarily for grease separation. Four primary settling tanks provide 2 hr. detention. Each of these pumps can pump sludge from any tank to either of two conditioning tanks, to any of 4 digestion tanks or directly to drying beds, and scum can similarly be disposed of. Primary tank effluent can go to 4 aeration tanks providing 5 hr. aeration, or by-passed to final settling tanks or to magnetite filter. Final tank effluent can pass through a magnetite filter, circular, down-flow type, which surrounds a cascade of concentric steps, to increase the oxygen content of the final effluent. Four circular sludge digestion tanks provide 3.5 cu. ft. per capita; can be operated single or multiple stage. The warm supernatant passes through the well of the gas holder, insuring above-freezing temperature there and giving opportunity for deposition there of a large part of its solids before returning to the incoming sewage. There are 2 open drying beds and one glass-enclosed, drained by porous concrete tile instead of the customary open-jointed vitrified pipe. The work is being done by WPA labor.[L1]

Results with Covered Filters

Two enclosed filters have been operated for a year at Wolverhampton, England. Both are 20 ft. diameter, one 13 ft. deep, the other 6 ft. The former has 18″ of 1½-2 in. stone on the top, the latter 12″ of 2-2½ in. stone. Compressed air is supplied to the former at 200 cu. ft. per min., to the latter at 600 cu. ft. The former was operated at 246 gpd per cu. yd., the latter at 1284 gpd (equivalent to 124 mgad). The former was intended to give complete purification in one stage; the latter, to give a partially purified effluent containing flocculated colloids in easily settleable form. For each filter the dosage was increased gradually and the rates named were reached only near the end of the year. Oxygen was discontinued for 6 weeks with the deep filter and the BOD of the effluent increased from 20.2 ppm to 35.2. This fifth gave at least 80% purification on the 4-hr. increased oxygen absorption test at all times. The shallow filter at its maximum rate gave 60% purification on the oxygen absorption test and 75% BOD reduction. The engineers of the plant consider that the process (a patented one) "is capable of utilization on the practical scale.[D2]

Activated Sludge Operation Under Pressure

An experimental plant has been operated for over two years at Gravesend, England, to determine the effect of pressure on the rate of oxidation of sewage in the presence of activated sludge; since the amount of gas dissolved by a liquid is a function of the pressure upon the liquid. Five tanks were assembled one above the other, and sewage flowed



Civil Engineering

FINAL EFFLUENT FILTER

Section of circular magnetite filter, Ley Creek sewage works.

Lithographed on stone by James E. Allen for U. S. Pipe & Foundry Co. Copyright 1939, U. S. Pipe & Foundry Co.

from the top to the bottom one; while compressed air was applied to the bottom one, giving a pressure on its water surface of 8.7 lb., and the same air passed successively through all five tanks. It was found that, when this plant and a standard activated sludge plant were producing effluents of similar quality from the same sewage, the former could treat 4 times the volume of flow per unit of capacity, used only ¼ cu. ft. of free air per gal., as compared to 2 cu. ft. in the standard plant, and produced a much denser sludge.[D3]

Bibliography of Sewerage Literature

The articles in each magazine are numbered continuously throughout the year, beginning with our January issue.

c. Indicates construction article; *n*, note or short article; *p*, paper before a society (complete or abstract); *t*, technical article.

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2. *p*. Purification of Sewage on Covered Filters. By J. Hurley. Pp. 605-607.
3. *p*. Effect of Pressure on the Rate of Oxidation of Sewage in the Presence of Activated Sludge. By R. Hicks. Pp. 607-608.

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3. Sewage Disposal in Sandy Soil. By E. S. Chase. Pp. 769-770.

G *Water Works & Sewerage*

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2. Disposal of Waste Activated Sludge. By A. J. Fischer. Pp. 1129-1130.
3. Operation of the Topeka Activated Sludge Plant. By T. R. Hazeltine. Pp. 1137-1142.
4. Another Sewage Plant Explosion (Dayton, O.). By M. W. Tatlock. Pp. 1150-1151.

H *Municipal Sanitation*

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2. Automatic Gas Heating Equipment Design. By M. A. Combs. Pp. 568-571.
3. Sewage and Waste Treatment in Mississippi, New York and New Mexico. By H. A. Kroeze, C. A. Holmquist, P. S. Fox. Pp. 573-574.
4. Corrosion of Metals (in Sewage Plants) and Protective Coverings. By L. M. Johnson. Pp. 575-578.

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1. Sun Creek Sewage Treatment Works. By G. D. Holmes. Pp. 808-810.

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1. Four-State Agreement on Delaware River Pollution. Pp. 9-10, 24.
2. A Glossary of Chlorination Terms. By E. K. Phelps. Pp. 14-16.
3. What High-Rate Trickling Filters Are and Do. Pp. 17-18.
4. *n*. Disposal of Garbage by Fermentation. P. 30.
5. Sewer Rentals in Ninety-two Municipalities. P. 33.

Water Course Pollution by Sewage

The Illinois Appellate Court, in Eckart v. City of Belleville, 13 N. E., 2d, 641, affirming the injunction of a city from further polluting a creek and for damages to the farmers affected, adopts the ruling in Barrington Hills Club v. Barrington, 357 Ill. 11, that, as riparian owners have a right to have a water course carry only such volume of water as may be collected by the drainage of the basin in which its flows, a city or village cannot increase or pollute such water course by the discharge of sewage therein without compensation, even though it is the only available natural water course for such purpose and even though the municipality has a sewage treatment plant of modern design.

The Mississippi Supreme Court holds (Thompson v. City of Philadelphia, 177 So. 39), that the liability of a municipality for damages to property from a sewerage system, under the provision of the state constitution that private property shall not be taken without compensation, is not dependent on negligence in improper construction or maintenance but for any special and different damage suffered by a property owner not common to the general public, caused by the construction and maintenance of the sewerage system, whether properly constructed and maintained or not.

If a city discharges water from its disposal plant into a gully, which connects with a stream, for over ten years, in an open, notorious, peaceful, uninterrupted and adverse manner, the Nebraska Supreme Court holds, (Hall v. City of Friend, 279 N. W. 346) that such city may thus acquire an easement for that purpose. Where the evidence is conflicting as to any obnoxious odors from the effluent from a city's disposal plant which are alleged to create a nuisance, the court will not grant an injunction, but reasonable time may be given to improve the operation of the plant. In this case the chemical examination of the effluent showed that the plant was functioning in a proper manner. The judgment of the trial court, granting the city 90 days to correct any improper odor by chemical treatment or other sufficient treatment as might be recommended by competent engineers, was affirmed.

Nature of Material Misrepresented

In an action for breach of contract for the construction of a sewer in a tunnel beneath city streets, plaintiff's claim was that the defendant represented that the tunnel work was a free-air job except for about 600 feet, but that the construction of 6,142 feet out of a total of 8,553 feet required the use of compressed air. The Second Circuit Court of Appeals (Montrose Contracting Co. v. Westchester County, 94 F. 2d. 580) held that borings made did not reach tunnel depth and were of little use in determining the type of tunnel contruction which would be required, so that the jury were justified in finding that the contractor did not have reliable information to show that the job was not a free-air tunnel job as represented. The plaintiff's items of increased cost were held proved.

Experiments on Treatment of Cannery Wastes

(Continued from page 11)

Mr. Warreck informs us that it is the objective in chemical treatment to obtain an effluent with a pH not less than 9.6, giving a sludge that dries quickly on drying bed without any offensive odors, usually cracking within twelve hours after the supernatant has been withdrawn, and becoming removable within 4 days; conditions not obtainable if the pH drops materially below 9.6. The pH of fresh raw wastes closely approximates that of the water used by the cannery, but decreases on storage, particularly during the hot summer months, necessitating prompt transmission for most effluent and chemical wastes.

Summary and Conclusions

As a result of the work in Wisconsin, certain conclusions have been drawn regarding cannery waste treatment methods and procedures, which may be summarized as follows:

1. Screening of the canning wastes studied should be through a 40-mesh rotary screen provided with an efficient water spray.

2. Alum may be substituted for ferrous sulphate in the treatment of pea canning waste with equal oxygen demand reductions.

3. Biological treatment of pea canning waste is possible provided means can be provided for building up a satisfactory growth on the filter prior to the canning season.

4. Silage juice cannot be satisfactorily treated by the use of chemicals. The best method of disposal is by land irrigation.

5. Screened beet waste can be best treated chemically with ten pounds of lime and four pounds of ferrous sulphate per thousand gallons of waste. The addition of the ferrous sulphate reduces the settling time, effects a better clarification of the liquid, and further reduces the oxygen demand. Treatment with zinc chloride and lime gives the best oxygen demand reduction but is comparatively high in cost.

6. Biological treatment of beet wastes gives an oxygen demand reduction of 60% with six passes through a rock filter operating at 458 gallons per square foot per day.

7. An oxygen demand reduction of 60% may be obtained with corn waste by the addition of lime and ferrous sulphate using the described procedure. Biological treatment of the corn waste gave a reduction of 70% when passed six times through a rock filter operating at 458 gallons per square foot per day.

8. Tomato waste may be treated with screening and plain sedimentation to accomplish an average oxygen demand reduction of 37%, chemical treatment with lime and alum with 54% oxygen demand reduction, and biological treatment on the crushed rock filter with 73% oxygen demand reduction.

9. Carrot waste may be treated chemically with a minimum of five pounds of lime and one pound of iron, per 1,000 gallons of waste or with eight pounds of lime alone, to give a reduction of approximately 75% of the oxygen demand.

10. In general the biological treatment of cannery waste would involve a larger initial cost for the installation but a low operating cost; while the chemical treatment process involves a relatively low installation cost but an increased operating cost over biological treatment.

Keeping Up With New Equipment

Floctrol, A New Flocculation Process

A new flocculation process and apparatus, known as the "Floctrol," for the treatment of sewage and waste water, and for water softening and industrial processing, has been developed by The Jeffrey Manufacturing Company.

This process, which has been in operation for many months in a large water treatment plant, obtains substantially complete removal of suspended and colloidal particles in the sedimentation basin, using a minimum of chemical coagulant.

The flocculation unit is a rectangular multi-compartment tank with a paddle wheel mechanism in each compartment. Placement of the holes in the partition for communication between compartments, at the center of agitation (at the shaft center) eliminates short circuiting.

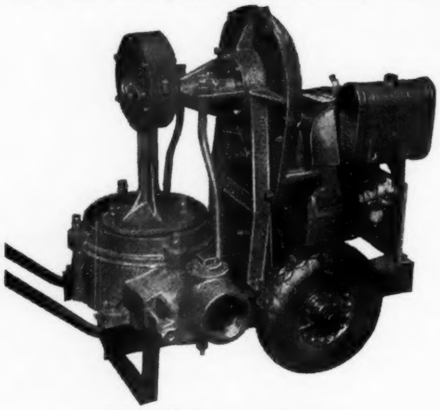
With this system a theoretical detention period of 30 minutes is ample for complete coagulation and flocculation. The time period required for each step of treatment varies. In the first zone or compartment where the paddle wheel mechanism has the greatest number of blades, only a short time is needed. Each succeeding compartment provides a longer detention period and the paddle wheel has fewer blades. In the last zone a relatively long period of time is necessary to build flocs to maximum size to obtain rapid settling of the particles in the sedimentation basin. This section has a paddle wheel arranged to provide only enough agitation to keep floc in suspension. The increase in time periods is proportional, to keep the tank size to a minimum.

These units can be furnished singly for flows of 1 to 10 m. g. d. or in multiples for large plants. Complete engineering data may be had by writing The Jeffrey Manufacturing Company, Columbus, Ohio.

Novo Light-Weight, Diaphragm Pump

Novo Engine Company, Lansing, Mich., have just announced a new, lightweight, compact, 3" diaphragm pump. This has completely enclosed gearing and a double braced eccentric which transmits the power to the pump. A 2½ h.p., air-cooled anti-friction engine is close coupled to the pump.

This is a standard A.G.C. 3" closed top pump with the standard rating of 3,000 G.P.H. at 10' suction and 1500 G.P.H. at 20' suction. Particular attention has been paid to accessibility. Removing four brass nuts permits inspection of both the suction and discharge valves. Two additional nuts remove the diaphragm. The pump, skid mounted, weighs only 370 lbs. It can be mounted on a two wheel, steel or pneumatic tired, truck. 4" model to follow.



Novo diaphragm pump.

Leon H. Zele of the Zele Chevrolet Co., Torrington, Conn., won the prize offered by Hercules Steel Products Co., Galion, O., for the best list of tools that can be carried advantageously in the tire and tool pack compartment, which is a feature of these Hercules bodies.

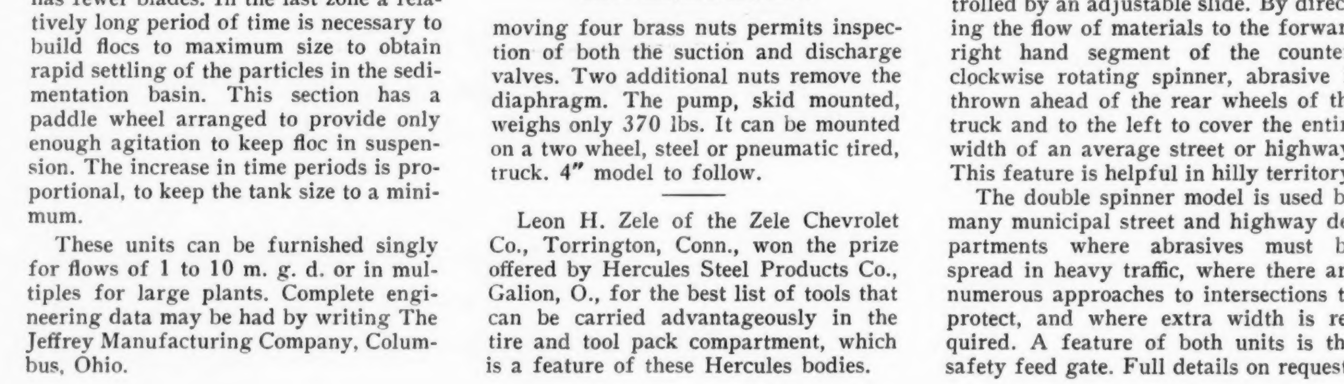
Sand and cinder spreader.

New Models of Little Giant Spreaders

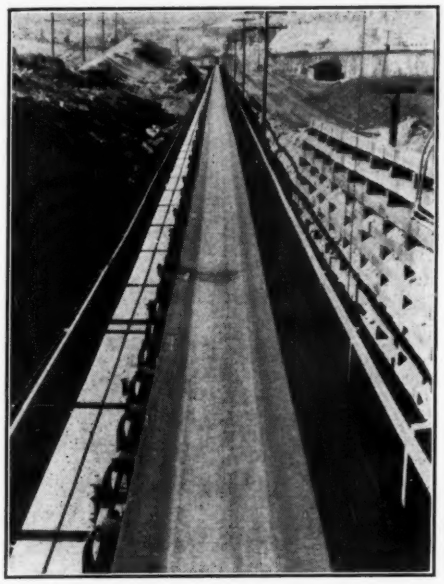
Portable Elevator Mfg. Co., Bloomington, Ill., has announced two new models of their Little Giant sand and cinder spreader.

The single spinner model has a movable rotatable bottom with one large feed opening, which may be located at any point over the circular spinner so that the spread may be in any direction. The quantity or density is easily controlled by an adjustable slide. By directing the flow of materials to the forward right hand segment of the counterclockwise rotating spinner, abrasive is thrown ahead of the rear wheels of the truck and to the left to cover the entire width of an average street or highway. This feature is helpful in hilly territory.

The double spinner model is used by many municipal street and highway departments where abrasives must be spread in heavy traffic, where there are numerous approaches to intersections to protect, and where extra width is required. A feature of both units is the safety feed gate. Full details on request.



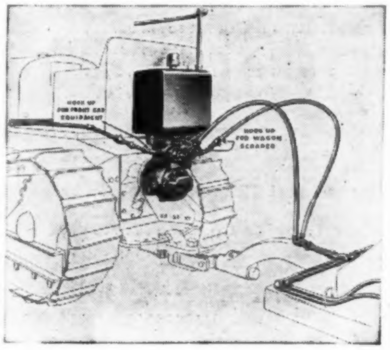
New flocculation process and equipment announced by Jeffrey.



Goodyear belt at Grand Coulee dam, 9700' long, carries 2000 tons of stone per hour. 120 bales of cotton were used in making the belt.

Continental Power Control Unit:

The Be-Ge hydraulic pump unit made by the Continental Roll & Steel Foundry Company, East Chicago, Indiana, is designed primarily for furnishing power to the hydraulic jacks that operate Continental wagon scrapers.



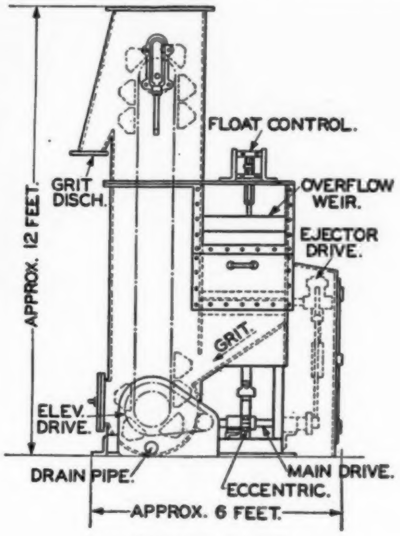
How the Continental control works.

It is made with extra outlets for operating tractor front-end equipment such as bulldozers, angle blades, loaders, shovels, etc. Tractors equipped with front-end equipment can be used simultaneously to pull wagon scrapers.

New Method of Sewage Grit Washing

A new unit—a "jig type" grit washer, fully automatic and requiring only 24 sq. ft. of floor space—is announced by The Jeffrey Manufacturing Company.

The operation of this grit washer obtains a clean grit of good appearance at a relatively low cost. The unit will treat up to 6 tons per hour, the washed grit



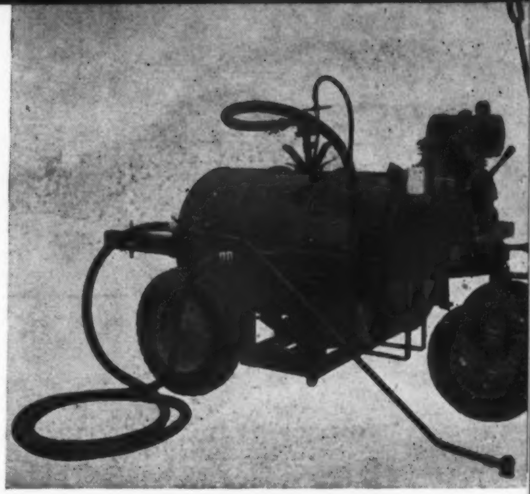
New Jeffrey grit washer.

containing less than 1% of putrescible solids, and being free from objectionable odors or unsightly appearance.

The manufacturer states that this new unit requires less than 2 H. P. to operate and that water consumption is unusually low, the maximum being four pounds of water to one pound of feed at the rated capacity. Organic solids are returned with the wash water to the grit channel. The clean grit from the washer is available for fills, walks or roadways.

Engineering data pertaining to this "jig type" grit washer may be obtained by writing The Jeffrey Manufacturing Company, Columbus, Ohio.

Willett Manufacturing Co., Grand Rapids, Mich., has purchased the patents, good will, trade marks, etc., of Willet Mfg. Corp., Plymouth, Ind., and will continue the manufacture of underbody truck graders, snow plows, blades, etc.; and has announced an improved underbody grader.



This is the new Tarrant sprayer unit for maintenance work.

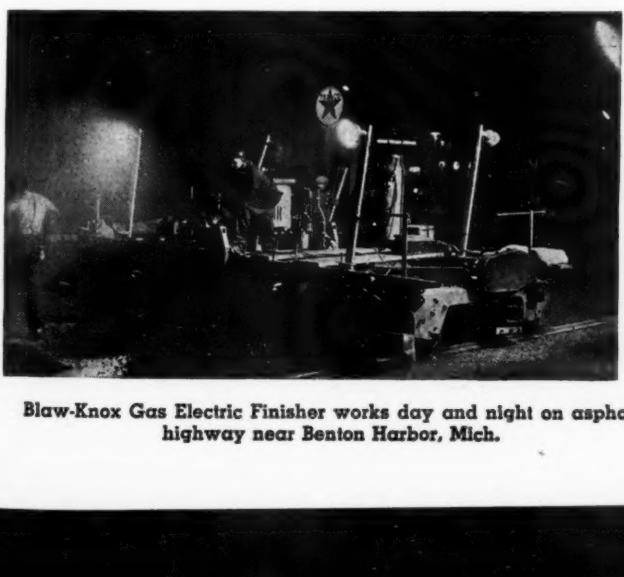
Tarco Asphalt Emulsion Sprayers for Maintenance

With one of these sprayers, a supply of stone or gravel, and cold fluid asphalt emulsion, the maintenance man or contractor can cope with a wide variety of problems. These include: The construction of paths, parking places and drives; sealcoating; widening; surfacing shoulders; penetration construction on side road approaches; applying non-skid surfacings, and many other of the duties outlined in the article on Highway Maintenance in this issue.

These sprayers are made in three types, all of which are basically the same. The "A" type is a hand sprayer; the "B" and "H" types are power sprayers. For full information on these units, write Tarrant Mfg. Co., Saratoga Springs, N. Y. An excellent bulletin is available.

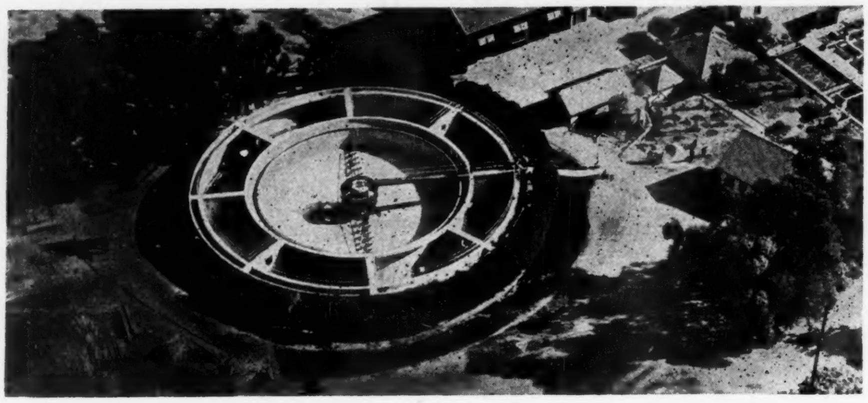
Austin-Western Special Training for Employees

The Austin-Western Road Machinery Co., Aurora, Ill., has made an important step in bringing men to their plant for special training in the application and handling of A-W equipment to highway and other construction. The men shown in the accompanying illustration are mainly recent college graduates, who have chosen this line of work. The course, which covered 10 weeks, included daily periods of classroom study on the application, uses and construction of all machines, their manufacture and distribution; sessions were also held on the proving ground of the company, the students handling the equipment.



Blaw-Knox Gas Electric Finisher works day and night on asphalt highway near Benton Harbor, Mich.

Austin-Western training group at entrance to main building, Aurora, Ill.



The Currie Claraetor at Pasadena, Calif.

The Currie Claraetor:

This is another of the Dorr family of equipment for sewage treatment. It is a self-contained unit for the clarification and aeration of sewage by the activated sludge process in a single circular tank. Aeration takes place in an outer annular compartment and clarification in an inner circular compartment, which is equipped with a Dorr Sifeed clarifier mechanism.

This equipment, which was developed by F. S. Currie of San Bernardino, Calif., and is being marketed by Dorr Co., Inc., is especially adapted to the requirements of municipalities with populations ranging from 5,000 to 15,000. Dorr Co. states that it gives results comparable with large, multiple tank, activated sludge plants and generally costs less to install and operate. Excellent bulletin from Dorr Co., Inc., 570 Lexington Ave., New York, N. Y.

Yeomans-Shone "Package" Sewage Lift Station

This is a complete pumping station for handling sewage and drainage—from municipal pumping stations to large buildings. The units are available in capacities up to 100 gpm. There are no moving parts; a rotary compressor mounted on the receiver furnishes compressed air to displace the sewage. There is no screen, and the unit will discharge solids that are close to discharge valve size; no floats, bells or air storage tank. For fuller information write Yeomans Bros. Co., 1409 Dayton St., Chicago, Ill.

National Paving Brick Association

The thirty-third annual meeting of the National Paving Brick Association will be held at Columbus, Ohio, February 1, 2 and 3, 1939, at the Deshler-Wallick Hotel. In addition to the business meetings many of the sessions will be open to the general public. Those interested in street and highway development are invited to attend.

The program, now in preparation, will include papers and discussions by prominent engineers and contractors experienced in the use of brick for paving purposes. Important recent developments in manufacturing, in the technique of testing and in construction practices will be considered. Among the subjects to be included are the Vibrated Monolithic Pavement, the additional experience with reinforced slabs and with the longitudinal method of laying, which are new uses of paving brick during the past year that have attracted widespread attention in the highway technical field. The Research Bureau of the Association is located at the Ohio State University Experiment Station in Columbus and opportunity will be afforded to inspect the laboratory and service studies.

The adaptability of brick as a heavy duty type to the "highway of tomorrow" will receive attention. Since the design of the modern express highway has to a large degree become stabilized the type of pavement should correspond with the planned permanence of the improvement.

C. C. Blair, head of the Metropolitan Paving Brick Company of Canton, Ohio, is president and George F. Schlesinger is chief engineer and secretary of the National Paving Brick Association.

Georgia Water and Sewage Association

The Georgia Water and Sewage Assn. has elected new officers for the coming year: Lloyd Jacobs, Assistant Superintendent, Newnan Water & Light Dept., Newnan, President; Clark Jones, Superintendent, Dalton, first Vice-President; L. D. Cannon, Pools Manager, Warm Springs Foundation, Second Vice-President; and Paul Weir, Superintendent of Filtration, City of Atlanta, re-elected Secretary - Treasurer. The Frederick J. MacMullin Memorial Award was presented to Carl Alexander, Superintendent of Filtration, Rome. The Association Awards for meritorious service were presented to Sherman Russell, Operator, City of Atlanta; E. P. Woodall, Supt. of Water Works, Blackshear; and J. M. George, Supt. of Water Works, Thomaston.

Frank Bachman, manager of the sanitary engineering sales division of the Dorr Co., Inc., New York, has transferred his headquarters from Chicago to New York, from which place he will continue to direct all Dorr sanitary engineering sales.

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ADVERTISEMENTS